



# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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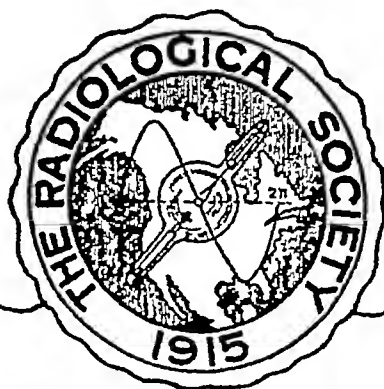
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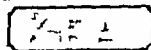
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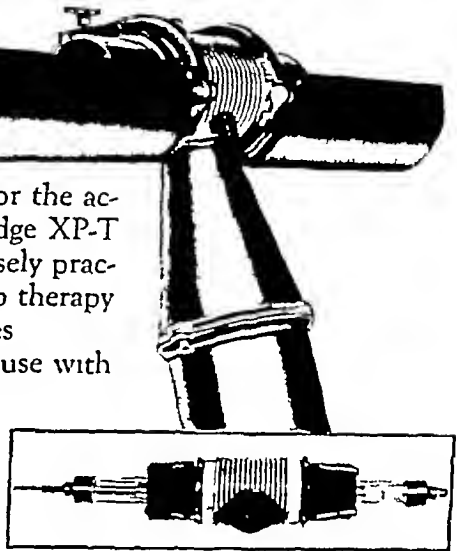
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VOL XXI

JULY, 1933

No 1

## THE ROENTGEN-RAY DIAGNOSIS OF INFLAMMATORY DISEASE OF THE APPENDIX<sup>1</sup>

By JOSEPH C BELL, M D, LOUISVILLE, KENTUCKY

ALTHOUGH much has been written concerning the roentgen-ray diagnosis of disease of the appendix, in this paper no attempt is made to review this material, for the reports here are based only on independent, personal observation. I have no doubt that many others have based their diagnoses on similar criteria. Within the past month Moore and Merritt<sup>2</sup> have described some of the same findings. Carman, in his book, "The Roentgen Diagnosis of Diseases of the Alimentary Canal," placed special emphasis on an article by Spriggs and Marver in *The Lancet* of 1919. This has undoubtedly formed the basis for much of the best work that has been done in roentgen diagnosis of disease of the appendix.

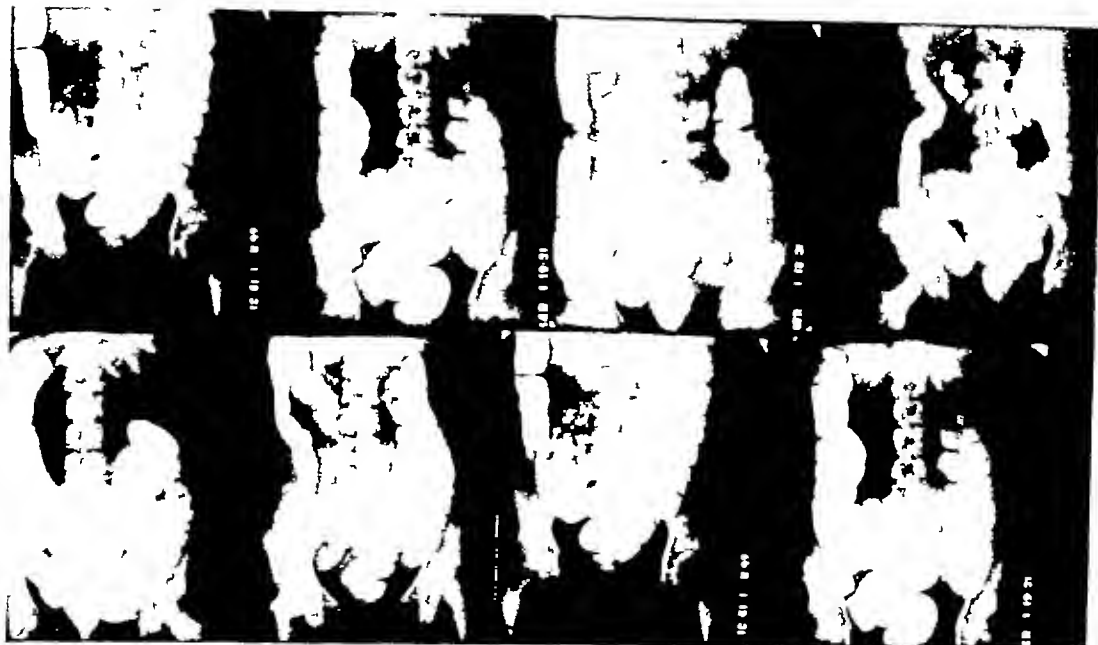
That all of the criteria advanced have been more or less unsatisfactory and unreliable is evident from the multiplicity of methods described, none of which has come into general use. Many surgeons of experience are hesitant to operate in cases in which a diagnosis of disease of the appendix has been made roentgenographically, evidently because previous experience

has shown that these findings are unreliable. These same surgeons know that the results of appendectomy in some cases of so-called chronic appendicitis are brilliant, but in a much larger group they are unsatisfactory. Because of this experience they recognize a real need for a type of examination that is dependable and will indicate with reasonable certainty the cases in which surgery is a consideration. I do not believe that this is true of any of the methods now in common use.

What are the indications for surgical intervention in disease of the appendix? In my opinion this must be answered from two viewpoints, the first being active inflammatory disease, and the second, mechanical disturbance resulting from previous inflammation in the appendix or other closely related structures. In active inflammation three grades are generally recognized, acute, subacute, and chronic. The characteristics of acute appendicitis are well known and do not require repetition. Spontaneous healing may take place or serious complications result. Subacute appendicitis may be a stage of subsiding acute appendix, which may later be followed by complete healing. On the other hand, there is evidence pointing to the fact that the stage of subacute inflammation may continue over a period of months or possibly years. The term "chronic-

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

<sup>2</sup>Moore A. B. and Merritt E. A. Roentgenologic Diagnosis of Appendicitis. Jour. Am. Med. Assoc. Nov. 14, 1931. Vol. 11: 1456-1457.



Figs. 1, 2, 3, and 4. Colons in normal individuals after barium enema without catharsis.

ic appendicitis," a loose one, generally covers any long-standing abnormality of the appendix due to active low grade infection or the result of previous infection. In the above classification it applies only to low grade, active inflammation. It may be a late stage in a subsiding acute appendicitis which will go on to complete repair, or it may continue as a low grade inflammatory condition for years.

The indications for surgical intervention in the acute cases are generally recognized. In subacute appendicitis they are not so clear, probably because accurate diagnosis is much less certain. Granting that the diagnosis is made, two courses are open: either to remove the appendix or leave it undisturbed. If an appendectomy is done, the possibility of future attacks is removed, as well as a probable source of focal infection. If it is left undisturbed, the infection may heal entirely or it may be followed by subsequent acute attacks. On the other hand, I believe that a low grade inflammation may persist for years and it is conceiv-

able that it may later cause disturbances in other organs. The possibility of some relationship between inflammatory disease of the appendix and peptic ulcer, gall-bladder disease and colitis is one that has been considered from time to time but has never been generally accepted. Much the same can be said of the low grade, active inflammatory cases known generally as chronic appendicitis. However low grade the inflammation, if it can definitely be established as active, surgery is at least to be considered. An abscessed tooth need not be causing acute symptoms to justify removal.

In the second group, non-inflammatory cases, surgery is chiefly indicated when there is hindrance to the normal passage of material through the intestinal tract as a result of the condition present. Adhesions in themselves may possibly cause discomfort sufficient to warrant intervention, but this is rare.

This paper is concerned only with the diagnosis of active inflammatory disease of the appendix in each of the above stages.

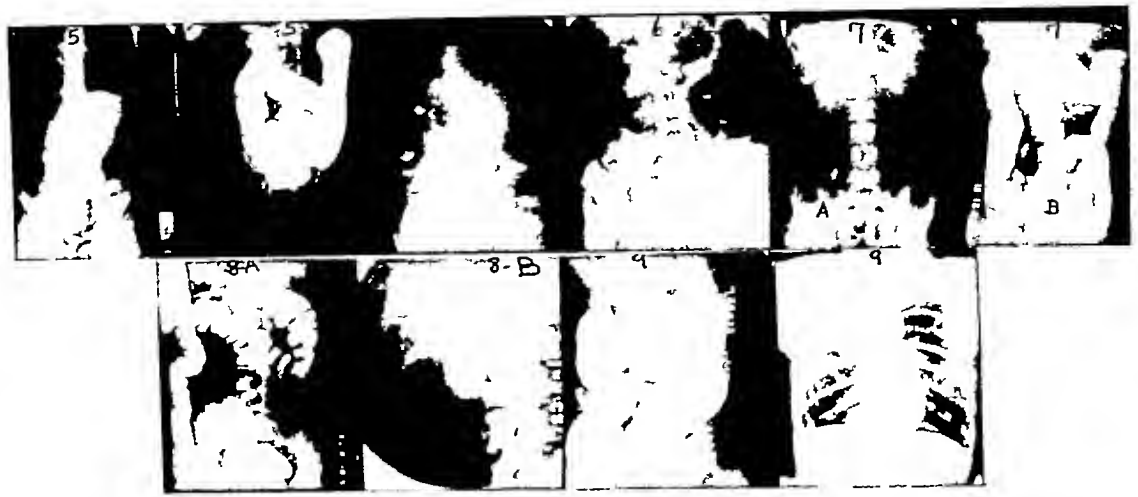


Fig 5 (upper left) Foreign bodies, two birdshot, in appendix

Fig 6 (upper center) Obstruction of terminal ileum Preliminary film shows dilated loops The second film was made after partial evacuation of a barium enema, with the patient upright Fluid levels in small bowel characteristic of obstruction can be seen surrounded by the colon

Fig 7-A (upper right) Large calcified lymph nodes above right side of sacrum in a young individual There are also calcium deposits in the spleen which cannot be well shown

Fig 7-B (upper right) Appearance after barium enema, showing relationship of lymph nodes to the cecum

Fig 8-A (lower left) Undescended cecum demonstrated by barium enema

Fig 8-B (lower left) Cholecystogram in same case with shadow of air-filled appendix lying slightly lateral to the gall bladder

Fig 9 (lower right) Tuberculosis of cecum, and film of chest in the same case

It is based on careful observation during seven years of the region of the cecum following a barium enema in all colon examinations, whether done as a part of a general gastro-intestinal examination, or alone Barium enemas have been used routinely in all gastro-intestinal examinations

It is a well recognized fact that disease in the duodenum and gall bladder causes marked disturbances in the motility of the stomach In general, the activity of the disease can roughly be determined by the degree of disturbance present in the stomach With this in mind, it occurred to me that active inflammatory disease of the appendix should cause disturbance in the motility of the cecum It was first considered in connection with the following case

Five years ago the mother of a physician came in complaining of some discomfort in the right lower quadrant She stated that she feared malignancy of the cecum having

had a dear friend die of this condition only a short time before A complete gastro-intestinal and gall-bladder examination was done, but the only finding of interest was extreme irritability of the cecum and ascending colon, so marked that it was impossible to visualize the structures satisfactorily This was associated with marked tenderness upon deep palpation over the region of the cecum Re-examination, after an antispasmodic, was recommended This was done in about ten days and the spasticity, although much less marked was still present It seemed evident from this examination that there was no organic disease in the cecum or ascending colon There was no suggestion of any other systemic disease special attention being given to the possibility of pulmonary tuberculosis In my report I stated that there was some possibility that the spasticity noted in the cecum might be associated with disease of

the appendix. The patient has had similar attacks at intervals since and has been re-examined at least four times. Varying degrees of spasticity have been present each time but the appendix has not been removed.



Fig 10 Early carcinoma of the cecum with partial obstruction of the terminal ileum

After observing this case I began to examine the right side of the colon with additional care in all cases. I soon discovered that in practically all instances contraction waves were present in the cecum when the colon was filled with opaque material. I found that it would be necessary to determine the range of normal contractions in the cecum and with this in mind, a series of cases in supposedly normal young adults was examined (Figs 1, 2, 3, 4). In all cases it was found that definite rhythmic contraction waves occurred in the cecum. In none of these cases were the cecum and ascending colon seen to empty nor were the contractions sufficient to expel the barium even for a short time. No mass peristalsis was noted in the right side of the colon in any case and no irritability was noted in the left side of the colon. Only one series was examined because of the difficulty in securing satisfactory persons.

#### TECHNIC OF EXAMINATION

Catharsis, even within a period as long as 24 hours is not advised when the possibility of inflammatory disease of the appendix is to be investigated. A barium enema may be given after the 24-hour observation in a gastro-intestinal examination or alone. When it is given alone, it should be preceded by a single film of the entire abdomen. This film is of great assistance in detecting gallstones, urinary tract stones, calcified abdominal lymph nodes, dilated loops of the small bowel, indicative of small bowel obstruction and other conditions which might be obscured after an injection of opaque material. The film should be examined carefully before the enema is given, for in some instances nothing more than the first film may be needed to fix the diagnosis. A suspension of barium sulphate in water at body temperature is used for the enema. It should be given slowly, preferably with the reservoir not more than 24 inches above the level of the patient. Before judgment is passed on the condition of the cecum and ascending colon the structures should be observed carefully, after filling, at intervals for a period of at least four minutes. Many abnormalities are undoubtedly missed by too hasty observation. After the fluoroscopic examination, at least one large film of the entire colon should be made using the Buck's diaphragm.

In all except one of the cases reported the diagnosis was based only on the behavior of the cecum and ascending colon in the presence of a barium enema. However in other cases barium was given by mouth and after an interval of about fifteen hours the patient was examined with the fluoroscope, after which the enema was given as above described. When this type of examination is employed additional information may be obtained. The appendix itself will be visualized in a high percentage of cases although it seldom is when the enema is given alone. Its position, mobility, general appearance

emptying time, etc., may be determined. These data may be of real value in diagnosis, especially in the presence of a low grade infection.

#### CONDITIONS NOTED IN THE PRESENCE OF DISEASE

Earlier in this paper it was stated that the cecum and ascending colon, in a supposedly normal individual, filled readily when a barium enema was given. Rhythmic contraction waves, normally present when these structures are moderately distended, were described. Spasticity was not noted in any case.

My observations would seem to indicate that, when the appendix is inflamed, the nervous mechanism of the cecum, and sometimes of the ascending colon, is disturbed, with resultant increased irritability, evidenced by varying degrees of spasm in the musculature of these structures. In the subacute and chronic cases, the irritability, in general, seems to be directly proportional to the degree of inflammation present. In the majority, the cecum and ascending colon can be filled, but they usually contract at intervals and may expel most of the opaque material. They may refill and contract alternately, more frequently they may remain contracted. In the low grade inflammatory type, the evidence of irritability, which may be slight, is often limited to the extreme dependent portion of the cecum near its junction with the appendix.

In many of the acute cases, generalized irritability is not present in the cecum or ascending colon. In some, the cecum fills quite readily and remains filled during the fluoroscopic examination. If there is any variation from normal, there is a hypotonicity. Just why this is the case I am not prepared to say, but it seems quite possible that this is due to a toxic nervous inhibition. This has most often been observed in cases in which evidence of infection has been pres-

ent for at least 24 hours, and it is quite possible that irritability was present earlier in the disease. It is unfortunate that this is true, for it detracts considerably from the value of this method of diagnosis in acute conditions. In other acute cases, a localized area of spasm, with more or less constant deformity, may be present even when, in general, the surrounding portions of the large bowel are hypotonic. In all of these types there may be a short interval after filling before evidence of irritability appears. This is especially true in the latter type. Some cases have shown irritability only after palpation over the cecum. It might be thought that palpation would cause spasm in normal cases, but this has not been true in those I have examined.

The irritability above described is entirely different from that seen in the condition commonly known as spastic colitis. In the latter, the irritability rarely extends proximal to the hepatic flexure, and, in my experience, it never involves the cecum. Much the same is true of all other forms of colitis except that due to tuberculosis or typhoid fever. Alfred Stengel, in his work entitled "Diseases of the Intestines," in Osler's "Modern Medicine," says that a true primary localized inflammation of the cecum, without appendicitis, does occur, although rarely. In these cases one might anticipate irritability of the cecum that could not be distinguished from the type above described.

#### APPLICATIONS AND LIMITATIONS

The type of examination above described, I believe, has a definite place in the diagnosis of inflammatory disease of the appendix. In acute cases, its use is limited because of the fact that disturbance in motility in the cecum and ascending colon may be absent. On the other hand, a properly given enema is without apparent danger and may give information of value. However, it must be definitely recognized that negative roentgen examinations do not rule out



the appendix. The patient has had similar attacks at intervals since and has been re-examined at least four times. Varying degrees of spasticity have been present each time but the appendix has not been removed.



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have been operated upon and the pathologists' findings are reported. Some have been examined and operated upon recently, others as long as two years ago. In the earlier cases, the colons have been re-exam-

It has been through the courtesy and cooperation of Dr Sydney E Johnson, Director of the Roentgen-ray Department of the Louisville City Hospital, and the resident staff, that I have had an opportunity to

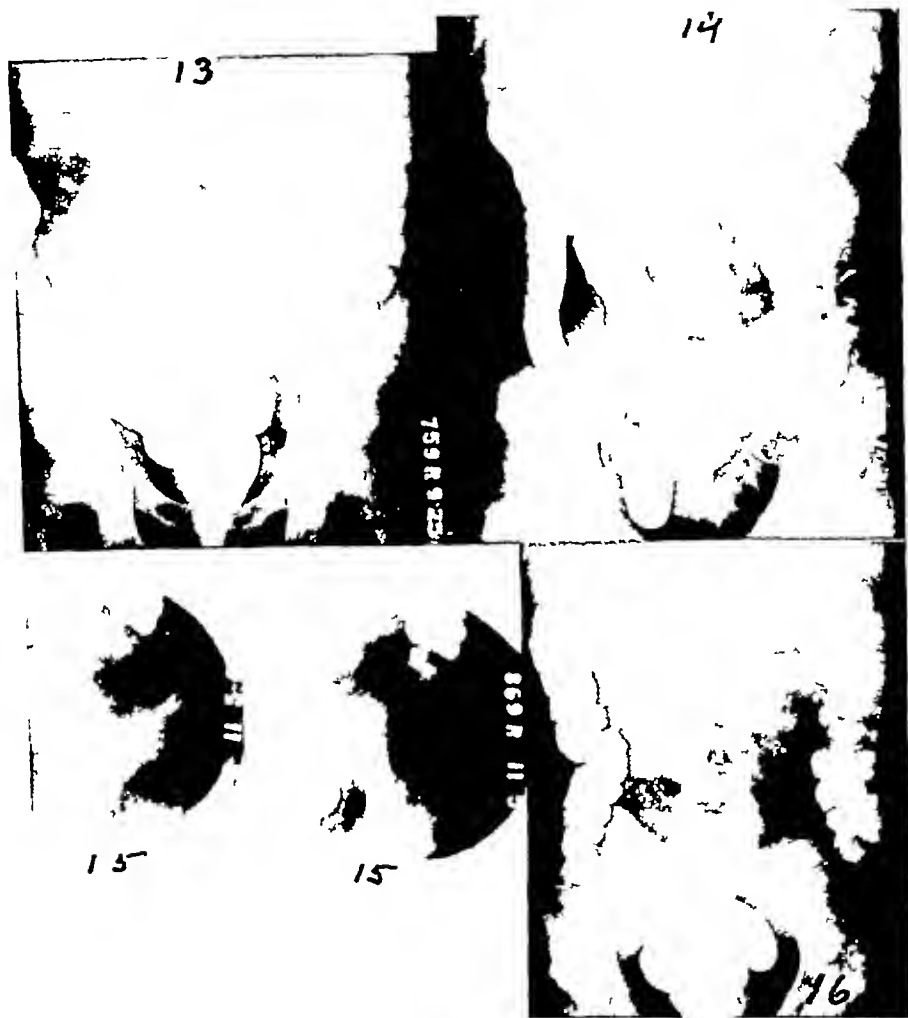


Fig 13 (*above left*) Case 3. Film made with barium enema 18 months after operation. A pre operative film was not available.

Fig 14 (*above right*) Case 4. Film made with barium enema before operation showing irritable cecum and ascending colon.

Fig 15 (*lower left*) Case 5. Two small films made about two minutes apart showing constriction of the deformity of the cecum.

Fig 16 (*lower right*) Case 5. Roentgenogram made with barium enema before operation, showing irritable cecum and ascending colon.

ined during the last two months and the findings, together with a statement of the patient's condition, are reported. These represent less than one-third of the cases examined in which positive diagnoses have been made.

examine some supposedly acute cases. Dr Johnson has been using a type of examination similar to mine for some time, and two of the cases reported were examined and diagnosed by him.

In one instance foreign bodies in an ap-

the possibility of acute disease. This was effectively demonstrated in one of my cases.

It is in the diagnosis of the subacute and low grade, so called, chronic types of active inflammatory disease that I believe this

decisional disease if the cecum or appendix is in contact with the tube. Early tuberculosis of the cecum may also be confusing until the chest is examined. Malignant disease in or near the appendix is another consideration,



Fig 11-A (above right) Case 1 Before operation showing slight deformity of the cecum

Fig 11-B (above left) After operation

Fig 12-A (below left) Case 2 Before operation, showing spastic cecum and ascending colon behind first part of transverse

Fig 12-B (below right) After operation Irregularity at the base of the cecum due to stricture in the terminal ileum

examination will find its greatest usefulness. In the chronic cases, especial care must be exercised before judgment is passed, for normal findings may be mistaken for abnormal, and, if the abnormalities are slight the results of operation may be in direct proportion to the degree of disturbance.

Inflammation or other disease in structures immediately adjacent to the appendix or cecum may cause changes that cannot be distinguished from those resulting from disease of the appendix. For example, a right-sided salpingitis may simulate appen-

although a relatively rare one. With an undescended cecum, it may be impossible to distinguish between appendicitis and gall-bladder disease. Carman reported one case of actinomycosis causing deformity of the cecum, but this condition is too infrequent to be a consideration in differential diagnosis.

#### CASE REPORTS

The following case reports have been selected as illustrative of various types of inflammatory disease of the appendix. All

of any active inflammatory process at the time of the appendectomy. This case is cited as an example of one in which it may be impossible to determine by x-rays alone whether the appendix or the pelvic organs is the site of the inflammatory lesion.

**Case 2** White, male, age 26 years. The patient came in giving a history of having had, three years previous to this examination, an acute illness characterized by acute pain in the right lumbar region, with tenderness in the right lower quadrant. At that time he was in the hospital for one week. A diagnosis of probable acute appendicitis was made, but he had a severe cold and was not operated upon. Since that time he had suffered from very obstinate constipation, headaches, and a sense of discomfort in the right lower quadrant much of the time.

A complete gastro-intestinal examination was done on Nov. 25, 1929. The stomach and small bowel were found to be normal. The appendix was visualized, lying partly behind the lateral third of the cecum and there was tenderness upon deep palpation over it. There was marked and constant irritability of the cecum and ascending colon (Fig. 12-A). In my report I stated that the findings were strongly suggestive of a low grade inflammatory condition in the appendix.

The patient entered the hospital on Dec. 18, 1929. The temperature was normal and the white blood cell count showed 8,400, with 68 per cent polymorphonuclear leukocytes. The pre-operative diagnosis was appendicitis, and an appendectomy was done.

*Operative Note*—Diagnosis: Subacute appendicitis. Large inflamed appendix isolated and removed. No free pus or fluid.

*Pathologic Report*—Appendix 4 × 0.25 inch. Lumen patent. Contains fecal material. Microscopic description: Lumen large. Mucosa destroyed in some areas and in others very thin. All structures densely in-

vaded with leukocytes. Microscopic diagnosis: Acute appendicitis.

The post-operative convalescence was uneventful and the patient was discharged after 10 days.

A barium enema was given to this patient on Oct. 5, 1931, almost two years after his operation. All parts of the colon were found to be normal (Fig. 12-B). The patient stated that he had been entirely free from symptoms since the appendectomy, that he had gained weight, and was free from constipation and headaches.

*Comment*—This patient had symptoms from his initial attack. Operation showed definite pathology and all symptoms disappeared promptly after the removal of the appendix. The location of the appendix evidently explained the peculiar posterior pain noted in the initial attack. There is every reason to believe that an active inflammatory condition persisted in the appendix from the first attack until the appendectomy.

**Case 3** The patient, who was referred for an examination of the gall bladder and colon, gave a history of having had attacks of abdominal pain upon two occasions, one just a week before the present examination. The attending physician considered that the symptoms were likely due to a subsiding acute appendix, for there was some tenderness in the right lower quadrant and a blood count showed 11,400 white blood cells with 89 per cent polymorphonuclear neutrophils, but he thought it wise to rule out the possibility of gall-bladder disease.

A cholecystogram showed the gall-bladder function to be normal. A barium enema was then given and the cecum and ascending colon were found to be very irritable. There was some tenderness upon deep palpation over the cecum. In my report, I stated that I believed there was a subacute inflammatory condition in the appendix. June 16, 1930, six weeks later, as the patient had had two mild attacks similar to the previous ones, an appendectomy was done. Tem-

pendix (Fig 5) caused sufficient discomfort to warrant surgical removal of the appendix. There was only the slightest spasm of the cecum in this case and microscopic examination of the removed appendix showed little evidence of inflammatory disease.

Dilated loops of the small bowel, typical of small bowel obstruction, were discovered by means of a preliminary film (Fig 6), made before giving the enema. There was no irritability of the cecum in this case. I reported that I did not believe the appendix was actively inflamed, but that there was a mechanical obstruction of the terminal ileum. Operation showed that the obstruction was due to a band extending across the terminal ileum.

An unusually large group of calcified lymph nodes, medial to the cecum, was discovered in one case, in the preliminary film (Figs 7-A, 7-B). The enema revealed no spasm of the cecum. All the tenderness present was sharply localized over the calcified glands. No operation has been done but I believe the glands, and not the appendix, are responsible for the symptoms.

A so-called inverted or undescended cecum was demonstrated by barium enema (Fig 8-A). Another film (Fig 8-B) of the same case showed the gall-bladder shadow, during cholecystographic examination, with the air-filled appendix lying beside it. One can readily appreciate the difficulties of differentiation between appendicitis and cholecystitis in this case.

Tuberculosis of the cecum secondary to advanced tuberculosis of the chest (Fig 9) and carcinoma of the cecum (Fig 10) were seen in two cases.

**Case 1** This patient, white, female, age 25 years, gave a history of having had an acute attack of right lower quadrant pain three years previously, accompanied by nausea and vomiting, which lasted over a period of three days. Recurrent attacks had taken place at intervals. The patient developed an obstinate type of constipa-

tion during this period. A short time before examination, she developed a rather troublesome dysmenorrhea.

X-ray examination of the entire gastrointestinal tract, on Oct 8, 1930, showed a constant deformity (Fig 11-A) of the dependent third of the cecum, associated with some irritability. The appearance of the cecum suggested that there were adhesions about it and an opinion was expressed that the changes were secondary to an inflammatory lesion in the appendix, probably of low grade activity at the time of examination.

In his operative note, the surgeon said that there were adhesions about the base of the appendix and the cecum and numerous adhesions surrounding the tubes, ovaries, and uterus. An appendectomy and a panhysterectomy were done. The patient's convalescence was uneventful.

*Pathologic Report*—Gross description: Some injection of vessels of serosa. No areas of hemorrhage. Microscopic description: Mucosa almost entirely replaced by fibrous tissue. Lumen entirely obliterated. Walls consist chiefly of fibrous tissue. A few areas of lymphocytic infiltration present. **Diagnosis:** Fibrosed appendix.

This patient was re-examined Oct 9, 1931, when only a barium enema was administered. The colon was found to be normal in tone (Fig 11-B). There was very slight deformity in the base of the cecum but no irritability was present. The patient informed me that she had been entirely free from symptoms since the operation. She also volunteered the information that the obstinate constipation had promptly disappeared and had not returned. She said that she considered herself to be in excellent health.

*Comment*—It is impossible to say with certainty whether the condition in the pelvic organs or that in the appendix was responsible for this patient's symptoms. Certainly the appendix showed very little evidence

of any active inflammatory process at the time of the appendectomy. This case is cited as an example of one in which it may be impossible to determine by x-rays alone whether the appendix or the pelvic organs is the site of the inflammatory lesion.

**Case 2** White, male, age 26 years. The patient came in giving a history of having had, three years previous to this examination, an acute illness characterized by acute pain in the right lumbar region, with tenderness in the right lower quadrant. At that time he was in the hospital for one week. A diagnosis of probable acute appendicitis was made, but he had a severe cold and was not operated upon. Since that time he had suffered from very obstinate constipation, headaches, and a sense of discomfort in the right lower quadrant much of the time.

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*Comment*—This patient had symptoms from his initial attack. Operation showed definite pathology and all symptoms disappeared promptly after the removal of the appendix. The location of the appendix evidently explained the peculiar posterior pain noted in the initial attack. There is every reason to believe that an active inflammatory condition persisted in the appendix from the first attack until the appendectomy.

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A cholecystogram showed the gall-bladder function to be normal. A barium enema was then given and the cecum and ascending colon were found to be very irritable. There was some tenderness upon deep palpation over the cecum. In my report, I stated that I believed there was a subacute inflammatory condition in the appendix. June 16, 1930, six weeks later, as the patient had had two mild attacks similar to the previous ones, an appendectomy was done. Tem-

perature and laboratory findings at admission were normal. In the operative note the surgeon stated that there was evidence of chronic disease in the appendix, together with adhesions between it and the outer side of the cecum.

*Microscopic Description*—Diffuse lymphocytic reaction. Increased fibrous tissue in submucosa. Diagnosis: Chronic appendicitis.

The patient was re-examined (Fig 13) on Sept 26, 1931. All parts of the colon were normal. The cecum was regular and not irritable. The patient stated that he had been entirely free from symptoms since operation.

*Comment*—At the time of my examination, this case was evidently one of a subsiding acute appendix. At operation, six weeks later, there was relatively little evidence of active inflammation, but the recurrence of symptoms apparently indicated the infection was still present.

**Case 4** The patient, white male, age 20 years, was referred on July 22, 1931, for an examination of the colon. He gave a history of recurrent attacks of abdominal pain extending over a period of six years. During the attacks there was considerable tenderness upon palpation in the right lower quadrant. The last attack took place two months before this examination.

In my report, I stated that the cecum was somewhat irritable (Fig 14). It was seen to contract several times and tenderness was noted upon deep palpation over the region of the cecum. It was my opinion that the irritability of the cecum was likely due to a low grade inflammatory condition in the appendix.

This patient entered the hospital on Aug 17, 1931, having had another attack of abdominal pain. The blood examination at that time showed a white blood cell count of 11,550. Polymorphonuclear leukocyte count was 76 per cent. Temperature at admission was 99 degrees. The patient was operated

upon, and the appendix was found to be long, kinked, with adhesions. The appendix was removed.

*Pathologic Report*—Gross description: Serosal vessels prominent. On section, the lumen of the distal portion is found to be filled with yellowish purulent fluid. The remainder is filled with semi-solid fecal material. Mucosa pale, yellowish brown and smooth. Microscopic description: Mucosa scarred in a few places. There are clumps of leukocytes beneath the serosa and also a few groups of leukocytes in the muscularis. The serosa is thin and the blood vessel walls are moderately thickened. Microscopic diagnosis: Chronic appendicitis.

The patient's post-operative course was uneventful. He is now out of the city, but, in conversation with a member of his family, in November, 1931, I was informed that he had been in excellent health since his operation and without abdominal symptoms of any type.

**Case 5** The patient, white male, age 29 years, was referred to my office Nov 5, 1931, for x-ray examination of the colon. His chief complaint was recurrent attacks of abdominal pain extending over a period of several months. An unusually severe attack occurred three weeks before my examination. It was characterized by nausea and vomiting and pain localized in the right lower quadrant.

My examination revealed definite evidence of irritability in the cecum and ascending colon (Figs 15 and 16). Three films were made and all showed a constant deformity of the dependent portion of the cecum, evidently spastic in origin. During the fluoroscopic examination, the cecum was seen to fill out at times, after which it contracted and the deformity reappeared. In my comments on the case, I stated that I felt there was little doubt but that there was a low grade active inflammatory condition in the appendix.

The patient entered the hospital one week

later and an appendectomy was done. In his operative note the surgeon stated that the appendix and cecum were surrounded by numerous adhesions. The appendix was subacutely inflamed.

X-ray examination of the colon showed rather marked irritability of the cecum (Fig 17-A) and ascending portion associated with considerable sharply localized tenderness. This was thought to be due to



Fig 17-A Case 6 Film made before operation, showing irritability of the cecum

Fig 17-B Film made 15 months after operation

*Pathologic Report*—Gross description: Serosa rough and reddened. Walls indurated. Lumen patent and empty. Petechiae in mucosa of distal third. Microscopic section: Moderate old fibrosis in submucosa and some recent fibrosis in mucosa. Mucosa edematous. There is a rather marked infiltration with eosinophils and plasma cells. In some areas the infiltration extends down into the submucosa. There are occasional areas of infiltration in the muscularis. Slight fibrosis of serosa. Microscopic diagnosis: Chronic appendicitis.

The post-operative course was uneventful. The patient left the hospital only a short time ago and it is too soon to determine the final results in this case.

**Case 6** The patient, white, female, age 22 years, was referred for examination on June 16, 1930. She gave a history of abdominal discomfort, nausea, a sense of burning in the stomach, headache, and constipation extending over a period of a year. There had been no acute attacks of abdominal pain. She had lost approximately 28 pounds in weight during the previous three years.

a subacute inflammatory lesion in the appendix.

The patient was operated upon on July 12. The surgeon's operative note was as follows: "The appendix was chronically inflamed and contained two concretions. There were dense adhesions between the cecum and the lateral abdominal wall, making a small pocket in which the cecum was fixed. The adhesions were divided and the cecum allowed to resume its normal position instead of being rotated outward as it had been before. The other structures were normal."

*Pathologic Report*—Gross description: The appendix measures 65 mm in length. The diameter is fairly uniform. The lumen is patent throughout and contains two small fecaliths. Mucosa pale pinkish gray and moderately injected. Microscopic description: There is an increased amount of connective tissue in the submucosa and beneath the serosa. There are a few scattered patches about the blood vessels showing chronic inflammation. Microscopic diagnosis: Chronic appendicitis.

The post-operative course was uneventful.



This patient was re-examined Oct 7, 1931 (Fig 17-B). There was still just a little irritability of the cecum. The tone of the entire colon was found to be very much more satisfactory than was the case before



Fig 18 Case 7 Film made before operation, showing irritability of the proximal colon

The patient stated that she was very much better than she had been before her appendectomy. She had gained in weight but she still had some abdominal discomfort at times. The headaches had disappeared and the constipation was much less troublesome than before.

**Case 7** The patient, white, female, was referred for examination on April 27, 1931, because of recurrent attacks of abdominal pain associated with tenderness in the right lower quadrant. The last attack had taken place a week before my examination.

A barium enema was administered. During the first part of the examination, the cecum filled out satisfactorily, but there was definite tenderness upon palpation over it. Both it and the ascending colon became quite irritable (Fig 18) and contracted frequently following palpation over the cecum. During the latter part of the examination, it did not completely relax at any time. In

my comment I stated that I believed there was a low grade active inflammatory condition in the appendix.

The patient was admitted to the hospital six days later. At that time the white blood cell count showed 10,650 cells with a polymorphonuclear leukocyte count of 68 per cent. The temperature was normal. After an appendectomy the surgeon's operative note was: "The appendix was short and injected. The meso-appendix adjacent to the appendix was white, thickened, and indurated. Operative diagnosis: Subacute appendicitis."

**Pathologic Report**—Gross description: The serosa shows a few fibrous tags. The walls are thin but firm. The lumen is patent and contains bloody mucoid material. Microscopic description: Mucosa thinned distally and replaced by dense, old, fibrous tissue which contains a moderate infiltration of plasma cells and lymphocytes, together with a few eosinophils. There is similar fibrosis of the submucosa throughout the length of the appendix and there is some leukocytic infiltration, although it is most marked in the tip. The serosa shows slight old fibrosis. In one area near the tip there is some recent fibroblastic tissue with a few newly formed blood vessels. Microscopic diagnosis: Healing appendix.

**Comment**—It would seem that this case might well be classed as a subsiding acute appendix, judging from the leukocyte count and the pathologist's findings.

An attempt has been made to have this patient return for a re-examination, but so far it has been impossible to arrange a time convenient to her. The last reports are that she is in good health and free from abdominal symptoms.

**Case 8** The patient, white, female, age 29 years, was referred for an examination of the colon on Aug 22, 1931. She gave a history of very obstinate constipation extending over a period of years, together with discomfort in the abdomen, especially in the



Fig 19-A (left) Case 8 Film made before operation, showing very irritable proximal colon  
 Fig 19-B (left) Film made eight weeks after operation The cecum is still slightly irritable  
 Fig 20 (right) Case 9 Two films made about one minute apart showing the constant deformity of the cecum and terminal ileum

right lower quadrant, for the past month. Laboratory findings were normal.

In my examination (Fig 19-A) I found that the proximal third of the colon filled satisfactorily, but almost immediately contracted. Several contractions resembling mass peristalsis were seen to start in the cecum and pass rapidly to the splenic flexure. During the latter half of the examination, the proximal third of the colon remained contracted the greater part of the time. There was some tenderness upon deep palpation over the cecum. I stated that the most likely cause of the above changes was an inflammatory condition in the appendix.

The patient entered the hospital shortly after the examination and appendectomy was done.

The surgeon stated that the tip of the appendix was several times the diameter of the proximal portion. In his opinion there was evidence of a subacute inflammatory lesion.

*Pathologic Report*—Gross description: The appendix was congested and edematous, especially at the tip. Microscopic description: There are large masses of lymphocytes in the subserous lymph spaces. There is edema of the muscular coat and a small number of neutrophils occur among the lymphocytes. Microscopic diagnosis: Chronic and subacute appendicitis, early.

The post-operative course was uneventful.

The patient was re-examined (Fig 19-B)

eight weeks after being discharged from the hospital. All parts of the colon were found to fill satisfactorily, but there was still a little irritability in the cecum at times. The tone of the remainder of the colon was very much more satisfactory than was the case at the previous examination. The patient stated that, aside from the fact that she was still somewhat constipated, she was free from abdominal symptoms.

**Case 9** The patient, white, male, age 50 years, came to the Out-patient Department of the Louisville City Hospital on Nov 9, 1931. He gave a history of recurrent attacks of dull, aching pain in the abdomen extending over a period of two years. These were associated with considerable gas and constipation, but there was no history of vomiting during any of the attacks. Four days before coming to the hospital he began to suffer from more pain localized to the right lower quadrant. He stated that this had been the most severe of any of his attacks. A white blood cell count was done at that time and 11,050 cells, 78 per cent of which were polymorphonuclears, were found. The temperature was 99. He was admitted to the hospital the following morning. The temperature was 100 degrees but fell to normal in the evening and remained so until operation. The blood cell count was repeated and found to be 6,600 with 80 per cent polymorphonuclears. The

abdominal symptoms were rather vague at that time and because of this a barium enema was administered. The medial side of the cecum was found to be irritable and a rather constant deformity was present (Fig



Fig 21 Case 10 Deformity of medial side of the cecum, secondary to acute appendicitis

20) The walls seemed to be relatively flexible. Quite a large amount of the opaque material escaped into the terminal ileum. This portion of the small bowel was narrow and irritable but at times it filled out quite well. Two films were made, and both showed much the same findings noted with the fluoroscope. The laboratory report stated that there was evidence of an extensive inflammatory lesion involving the terminal ileum, ileocecal valve, and a considerable portion of the cecum, probably due to an extension from the appendix.

When laparotomy was performed, the appendix was found to be acutely inflamed and surrounded by adhesions. There was an ulcer at the base, at which a perforation had evidently taken place and where a small walled-off abscess was found. The walls of the terminal ileum and adjacent portions of the cecum and ascending colon were markedly thickened and indurated. An appendectomy was done. The patient is still in

the hospital. Considerable temperature was present following the operation but it is gradually subsiding to normal.

*Pathologic Report*—Gross description. Specimen consists of an appendix measuring 6 cm in length. Its diameter is 1.5 cm and is uniform. Near the proximal end there is a ragged opening about four millimeters in diameter, extending entirely through the wall. The serosa is ragged with old connective tissue adhesions. The color is dark blood-red, evidently from an old hemorrhage. The wall varies from 5 to 7 mm in thickness, cuts with resistance, and its sectioned surface has the appearance of scar tissue. There is a small amount of mucosa at the tip, but the remainder is ulcerated and hemorrhagic. The perforation mentioned above is evidently the result of ulceration from the mucosa outward. There is no fecalith.

*Microscopy*—Sections of the tip show the mucosa intact, but the submucosa has old scar tissue. In the serosa there is also much scar tissue which is well matured, but contains a few lymphocytes in its outer portion. Other sections show the mucosa sloughed and, in one place, the muscularis and serosa are ulcerated. In all coats there is much scar tissue, the oldest being in the submucosa and in the outer coat next to the musculature. On the outer side there is a zone of blood clot which is organizing. The leukocytic infiltration varies from dense collections of lymphocytes surrounded by old scar tissue to large areas of polymorphonuclear cell infiltration. In these there is recent necrosis. The changes suggest former attacks of inflammation, some of which are apparently well healed, others in the process of healing and a recent one of a week or more duration, and the repair of this attack has begun. Diagnosis: Acute appendicitis, recurrent.

*Comment*—The findings, when this patient presented himself for admission to the hospital, were not characteristic of an in-

flammatory disease of the appendix although they were suggestive. The x-ray findings were of considerable aid in determining the exact conditions present and were very well borne out at operation.

Case 10 The patient, white, female, was admitted to the hospital Nov. 6, 1931, complaining of abdominal pain of 18 hours' duration. A short time before coming to the hospital the pain localized in the right lower quadrant. The patient had vomited three times. There was no history of similar attacks.

Physical examination showed rigidity of the muscles on the right with rather extreme tenderness in the right lower quadrant, together with rebound tenderness. The white cell count was 20,000 with 92 per cent polymorphonuclear leukocytes. Temperature was 99.5 degrees.

A diagnosis of acute appendicitis was made but a barium enema was given in order to determine what changes might be present in the cecum and ascending colon. All portions of the colon filled very satisfactorily except that the medial side of the cecum was constantly irritable and a filling defect was present (Fig. 21). This appeared to be spastic in origin, for it partly disappeared at times. There was no generalized spasm of the cecum.

After completing the examination, I stated that the patient evidently had an acute appendicitis and that this was responsible for the filling defect noted. Before seeing other acute cases, I had expected to find generalized spasm of the cecum, but, when this one was examined, I realized that this was not a constant finding.

A laparotomy was performed and an acute appendix was found and removed. The pathologic report stated that the appendix was covered with exudate and the lumen was patent and contained mucopurulent material. The mucosa was eroded, reddish, and edematous. In the microscopic description it was stated that all of the coats

were involved in an inflammatory process in which there was diffuse infiltration of polymorphonuclear leukocytes, plasma cells, and lymphocytes. Some areas of hemorrhage were present. Microscopic diagnosis was acute appendicitis. The post-operative course was uneventful.

Case 11 The patient, white, female, was admitted to the hospital Oct. 21, 1931, complaining of abdominal pain of 12 hours' duration. This was associated with nausea and vomiting. Shortly before coming to the hospital the patient had localized pain in the right lower quadrant. Physical examination showed marked tenderness in the right lower quadrant. The blood examination showed that 15,000 white cells were present with 81 per cent polymorphonuclear neutrophils. Temperature 99.8 degrees. A diagnosis of acute appendicitis was made, but the patient was referred to the X-ray Department for a barium enema.

All parts of the colon filled satisfactorily, including the cecum. No irritability was noted and there was no evidence of any deformity in the outline of this structure.

After completing the fluoroscopic examination I stated that I did not believe the patient had acute appendicitis because the cecum was not deformed and no irritability was present. I was basing this entirely on the x-ray findings for the clinical ones were characteristic of acute appendicitis. This was one of the first acute cases that I had examined and I did not believe that an acute inflammatory process could be present without causing some disturbance in the motility of the cecum. A laparotomy was done and an acute appendix found. It was removed and the convalescence was uneventful. Unfortunately the films were lost and cannot be used to show the findings in this case.

*Comment*—This case illustrates very well the fact that an acute inflammatory condition may be present and not cause any changes in the cecum. It shows that lack of findings in this type of examination do

not rule out with certainty the possibility of acute inflammatory disease of the appendix

#### COMMENT

I cannot refrain from quoting a paragraph written by Carman more than a decade ago. He said "On the whole, the value of roentgen signs of appendicitis appears to depend not only upon the intensity of the examiner's endeavor, but also, to some extent, upon the degree of his enthusiasm. Inasmuch as few normal appendices have been found by surgeons or pathologists, the diagnosis of appendicitis upon any ground whatever is not at all hazardous, but the novice should make sure that the appendix has not previously been removed, lest he mistake barium in the ileum for a shadowed appendix and draw his conclusions accordingly."

This is as true to-day as it was then. But it is not enough to diagnose appendicitis in all cases that will show some evidence of past disease, for, in a large percentage of these, the changes have no relationship to the patient's symptoms and an appendectomy will, in most instances, not produce results that are satisfactory either to the patient or surgeon. If our opinion is to be valued, we must go deeper and discover the cases in which the appendix is likely to be causing symptoms. To my mind, the logical working basis for this, in most instances, is an attempt to determine if active inflammation is present. Pathologists could aid us greatly, if, in addition to their regular report, they would state if, in their opinion, evidence of active inflammation is present and its degree.

The mortality from appendicitis is such as to give physicians in all branches of medicine grave concern, and the problem of diagnosis is of sufficient importance to merit our most thoughtful consideration.

#### SUMMARY

1 Normal roentgen-ray findings in the

cecum and ascending colon after a barium enema are described

2 Variations from normal in the presence of active inflammatory disease of the appendix are outlined

3 Cases are presented illustrating the value of the roentgenographic examination in diagnosis of inflammatory disease of the appendix. Some of the cases were re-examined after operation and the findings are reported

4 Barium given by mouth and followed by a barium enema after an interval of from 12 to 15 hours should give the most information in the majority of cases

5 The final diagnosis in any case must be based on all the findings, clinical and otherwise, and not upon those of x-rays alone

#### DISCUSSION

DR EVARTS A GRAHAM (St Louis) I do not know why I was asked to discuss this paper because, as you all know, I am not a roentgenologist, and my information about these matters is far from expert. There are, however, one or two things that I would like to say about appendicitis. Chronic appendicitis has done more to discredit surgery than, I suppose, almost any other so-called diagnosis that is made. The difficulty, it seems to me, is largely what Dr Bell has brought out, namely, it concerns itself with the matter of definition.

I am not speaking now about acute appendicitis. I take it that that offers no particular difficulty in diagnosis or no particular difficulty, theoretically, in treatment. Despite the fact that the mortality in acute appendicitis is disgracefully high throughout the country, the difficulties really do not exist to the same extent in that condition that they do in so-called chronic appendicitis.

There are some who take the extreme position that there is no such thing as a chronically diseased appendix. That is a position, which, in my opinion, is not justified. We surgeons know that frequently we relieve a patient of symptoms by removal of an appendix which contains fecaliths, or one which is the

site of recurrent acute attacks, or one which has become a so-called mucocoele, or occasionally even one which appears relatively normal

The difficulty which confronts us, however, is that in one case we will see an appendix which looks exactly like the appendix in another, yet the results in the two cases will not be at all the same. In one perhaps the result will be brilliant, in another, the patient will be no better, or perhaps he will be even worse after the operation.

When we appeal to the pathologist, we have again the same difficulty that Dr Bell has brought out, namely, it is extremely difficult for a pathologist to tell us whether or not the picture which he sees in a particular appendix is sufficient to cause symptoms. We, as clinicians, are primarily interested, not so much in the changes noted by the pathologist under the microscope, as to whether or not they can be correlated with the patient's symptoms.

If you roentgenologists can help to define chronic appendicitis by functional changes which you see in your examination of patients, you will do much to remove this discredit from clinical surgery to-day. You are in a position to establish the picture of chronic appendicitis, insofar as it relates to clinical symptoms, much better than are the pathologists or surgeons, because, of course, symptoms are produced only by disturbed functions. Pathologic changes create symptoms only because they disturb the normal functions.

You who look through the fluoroscope and take x-ray films are able to note changes in function. After all, that is the chief value of the roentgen examination of the viscera. It is a means for testing functions of almost all the organs in the body. If you could see merely pathologic changes or anatomic defects, roentgen diagnosis would not be half so valuable.

I am not at all prepared to enter into any critical discussion of Dr Bell's paper. He was kind enough to send me a copy of it, and I was tremendously interested in reading it. I have been greatly pleased, also, with the satisfactory results which he has recorded after operation on the cases in which he has utilized the method about which he has told you. I am a little sorry that he did not tell

us more about his failures. It may be that he has had none. I hope so, but it is interesting to hear the other side of the story.

Just a word about this question of functional diagnosis, that is, the diagnosis of disturbed functions. I think it would be a wise thing for everybody to remember that symptoms are produced only by disturbed functions. An appendix which is definitely diseased in the eyes of the pathologist may not produce any disturbed functions and, therefore, may not be the cause of the patient's symptoms. That is important to remember, because if such an appendix is removed from the patient, he may be no better than before.

There are many other disturbances in the abdomen causing symptoms which are often erroneously confused with chronic appendicitis, but it would be impossible for either Dr Bell or myself to take them up in the course of a short discussion. As a practical clinician I would say that one of the most common ills which is not infrequently confused with chronic appendicitis, and which discredits operation for appendicitis, is ordinary constipation.

As a surgeon, I see frequently the results of operation on patients with chronic constipation—I see it perhaps more often than you roentgenologists do. We also see many patients who have been unwisely and injudiciously operated on because all the time they have had a disease of the gall bladder. The gall bladder has not even been examined because the pain was on the right side of the abdomen, and everyone thinks of appendicitis once the appendix has been incriminated.

I feel myself that a diagnosis of chronic appendicitis should not be made without a complete gastro-intestinal examination of the patient as well as a complete clinical examination. I would certainly be unwilling to submit myself to an operation for the removal of the appendix merely on roentgenographic evidence. However, I am perfectly willing to be convinced that I may be wrong on that point, and I hope that Dr Bell's lead will enable us to tell with more precision about that matter.

DR L. R. SANTE (St. Louis). It has not been my good fortune to find a uniformly sat-

isfactory method for the diagnosis of appendicitis. I think, therefore, that we must give our utmost consideration to this condition. Dr. Bell has noted, the hyperirritability of the cecum. I am sure that, in certain instances, I have observed spasticity of the gastro-intestinal tract, but this does not seem to be confined to the cecum. In other words, this same hyperirritability may be present any place along the gastro-intestinal tract.

I recall clearly one instance of acute appendicitis with abscess formation, in which there was a spastic hour-glass constriction that completely divided the stomach. I recall another instance of a large appendiceal abscess which by pressure caused a rounded defect on the large atonic cecum. It thus appears that spasticity of the cecum cannot be considered uniformly present in appendicitis. That spasticity of the cecum does occur, however, I am quite convinced, but that it can be considered as pathologic I am not convinced.

It is difficult to check the reliability of one's findings in appendicitis. From the platform one pathologist made some such statement as this: "I can take out your appendix, or yours, or yours, or yours and send it to the pathologic laboratory and find evidences of pathology." As was brought out in Dr. Graham's observation, although he may have had his appendix removed the patient may continue with symptoms, thereby showing that the appendix was not the offending organ. In other words, the appendix may present evidences which are definitely pathologic and yet may not be the site of the trouble.

Our criterion for roentgen diagnosis of appendicitis has been on the following five points, which are given in the order of their importance:

- 1 A painful point directly over the appendix.
- 2 Malposition of the appendix, an excessively long appendix extending into the pelvis or up into the gall-bladder area, etc.
- 3 Restriction of mobility due to extrinsic adhesions or restrictions of motility due to previous inflammatory processes interfering with peristalsis.

4 Inclusions in the appendix.

5 Delayed emptying. The fact that the appendix does not fill does not mean it is, or is not, pathologic.

I think that while we must give our utmost attention to Dr. Bell's observations, we are not justified in making any kind of absolute statement on findings of this sort, because they are apt to be caused by other lesions of gastro-intestinal character.

DR. A. DAVID WILLMOTH (Louisville, Ky.) Those of us who open the abdomen frequently know that we have in appendicitis two types of persons: one presents acute appendicitis, with diarrhea, and the other comes with constipation (or, if we want to use the old term, obstipation), which was most likely diagnosed by the doctor who first saw the case as intestinal obstruction.

As far as I know, Dr. Bell's observation is the first that has been made to try to classify this condition or to see what happens in this type of case. I am quite sure that if the Doctor had been able to follow his cases all the way through, or perhaps over a period of time, he would have found that the cases presenting spasticity at the head of the colon would eventually have had the diarrhea. They would have come to the operating table as cases in which the bowel had moved a number of times just previous, perhaps, to the removal to the hospital.

Those in which there was no notice of the rapid constriction of the head of the colon would eventually have come as cases of intestinal obstruction and been diagnosed as such, the blood count and Schilling differential count determining the surgeon's decision.

If there can be any indictment brought against Dr. Bell's paper, it is the question of injecting barium for observation in suspicious cases of an acute appendix with high blood count. In such cases, you might arouse an appendix into activity or you might burst the colon.

I want to take exception to the question of a chronic appendix. Is there such a thing as a chronic inflammation? I do not think so. Inflammation is an acute process brought about by bacterial invasion, usually of pri-

ogenic variety, the irritation that you see in the appendix is a chronic hyperemia, generally the result of adhesions there. It is not an inflammatory process in any sense of the word. If it were, the patient would have to have something done.

After all, there are two places for studying pathology, one is the operating table and the other is the mortuary slab. That is where we see what really happens in a belly to cause trouble. One of the speakers very aptly said that it was hard to tell what is going on. In cases showing the most marked symptoms, if you open the abdomen you will find the appendix practically normal. In other cases in which there are no symptoms, no change in the blood count, you will find the appendix to be rotten. What is the difference? It is a question of the protection of the patient's system. Why does one get diarrhea? Due to irritation of Meissner's plexus and the Auerbach's plexus, there is stimulation of the gut. That is why a diarrhea is present. If there is a partial paralysis of the nerve supply, constipation or intestinal obstruction is present.

I think the Doctor is in a field in which he may be able to give the surgeon some valuable information, if he can follow his cases farther and can see what happens for the next few hours. As long as they are in no acute danger, there will be no objection to his following the case. If he wants to take plates as a record, all right. Personally I would much prefer a fluoroscope. In my own clinic I do not take plates of a suspicious appendix. I would much rather depend on the fluoroscope and see where I am putting my finger. If the patient is tender, I am pretty safe in saying that the trouble is about the appendix.

This brings me to another thought, and that is the matter of the chronic gall bladder, brought out by Dr Graham. I am referring to the incision of 1.5 inches that is made when appendectomy is performed. I thought the day was over when incisions 1.5 inches long were made. When you open an abdomen, you make an incision long enough to make a diagnosis. Unless you do that, how do you know what else is in the abdomen? When you go down to the mortuary slab you find that you missed the entire target. You would not have

done that if you had opened through a longer incision in the border of the right rectus muscle. The same incision will take you up to the gall bladder. I think Dr Sante mentioned some important points, and among them is the question of how much you are going to rely on what you see there. I know of no absolute, sure sign of what is going on in the abdomen. The late beloved Dr Deaver said a long time ago that no man living could tell you what was going on in the abdomen with an acute appendix. After many years of abdominal surgery, I want to say that I fully agree with what he said years ago. No man *can* tell what is going on there.

DR F C CHRISTENSEN (Racine, Wis.) I am wondering how much of the deformity of the cecum may be due to its being, in many instances, from 50 to 75 per cent extraperitoneal. It would be interesting to study a series of cecums and verify on the operating table the relation of cecal deformity to the degree of peritoneal covering present. Adhesions, either congenital or following inflammations other than appendicitis, may cause the deformity.

Dr Bell is right about the importance of a complete gastro-intestinal barium study. However, the expense incident thereto is often objectionable, even prohibitive, especially under present economic conditions. I have found it satisfactory to make 6- and 24-hour studies of barium meals in these cases, and which may be done at a nominal expense to the patient.

I should like to have Dr Bell tell us what his findings of cecal deformities have been after barium meals. Sometimes it is difficult to obtain a good cecal filling with a barium enema, as well as being more expensive and time-consuming.

In his discussion Dr Graham mentioned the frequent pitfalls into which a diagnosis of chronic appendicitis leads a surgeon. He said that if a gall-bladder study were made the result would be more correct diagnoses and fewer operations for chronic appendicitis. I should like to add that no operation for chronic appendicitis should be done until the question of pyelitis and ureteral strictures has been given serious consideration, especially in



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## THE INFLUENCE OF FILTRATION ON SURFACE AND DEPTH INTENSITIES OF 200 K V X-RAYS<sup>1</sup>

By EDITH H. QUIMBY, M A., and L. D. MARINELLI, B S., Department of Biophysics, Memorial Hospital, New York City

THE necessity of a filter for removing undesirable soft radiation has been recognized since the early days of radiotherapy. During the time when only comparatively low voltages were obtained, filters were commonly of aluminium, glass, leather, or combinations of these materials, and were established arbitrarily in various clinics. With the development of x-ray tubes to operate at higher voltages, and the introduction of instruments for measuring the radiation, the question of filtration began to be studied experimentally.

The criterion was established that, for radiation to be satisfactory for deep therapy, it should be homogeneous. For practical purposes, radiation is said to be homogeneous when its absorption curve, plotted to a semilogarithmic scale, is a straight line. At first, homogeneity was determined with respect to absorption in aluminium, since this metal was being used for other physical studies of the roentgen rays. Later, when it was recognized that homogeneity should be determined with respect to a substance more closely resembling tissue, water became generally used.

The thickness of aluminium, or glass, filter necessary to deliver radiation homogeneous with respect to absorption in water increased rapidly as higher voltages were attained, and it became expedient to use other metals. Iron, copper, and zinc were the most practical, particularly the two latter, which were found to be almost equivalent in filtering effect. Jungling, in 1920, summarized the work which had been done up to that time, and concluded that from 0.5 to 0.75 mm of copper or zinc was the

necessary and sufficient filter for radiation in the neighborhood of 200 K V, the exact amount depending on the type of apparatus and tube (1). This, with 1 or 2 mm of aluminium as a secondary filter, has remained fairly standard for deep therapy.

However, in studying the ever important question of how to increase the depth dose, experimenters found that one means was to increase the filter. In other words, the optimum condition had not been found when so-called homogeneity was reached. In a paper from the Memorial Hospital in 1923, the increase in depth dose with increase in copper filter for thicknesses up to 1.7 mm of copper was discussed (2). Small increases in depth dose were found with increase in filter, but, in order to obtain these increased doses, it was found that the irradiation time had to be increased in a much higher ratio.

Such investigations as this showed that, from the point of view of the depth dose delivered, there was a certain advantage in increasing the filter. They emphasized, however, the economic difficulty of making such changes in a busy clinic where, if every treatment were made twice as long, fewer patients could be cared for. On this basis, it gradually came about that two standard filters were established, according to their practicability in a given institution, 0.5 mm of copper if there was a great pressure of patients, and 2 mm of copper if there were sufficient facilities to permit its use. Copper in a thickness of 2 mm was not considered an optimum filter, it was simply a compromise to obtain the greatest possible depth dose compatible with a practical irradiation time.

There had been no reason for supposing

<sup>1</sup>Read before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City, Nov. 28-Dec. 1, 1932.

women Perhaps 50 per cent of the surgeon's failures to secure relief by removing a so-called chronic appendix may be charged to pyelitis and ureteral strictures

DR S C BARROW (Shreveport, La) I believe that we have done a great deal of good down in my section in our work on examinations of the chronic appendix, and I take the stand that there is a difference between a chronic appendix and chronic appendicitis I feel that radiologists have more to do with the chronic appendix than with chronic appendicitis

The question is Can we show whether or not we have a chronic appendix? One of the greatest fighters on this issue was our lamented friend, Dr John Deaver He performed 740 consecutive operations on what he called cases of chronic appendix, enumerating the pathologic findings They were, as I remember them, a congested condition, an inflammatory condition, fibrous tissue formation, elongation and dilatation, clinging and fixation He found those conditions in the 740 cases upon which he operated Therefore, I say that if we can demonstrate those conditions pre-operatively, we can truthfully say that we can diagnose a chronic appendix

Fluoroscopically the congestion and inflammations in an appendix are present by the sense of touch as responded to by the patient, and I believe that the painful point, fluoroscopically, is one of our strongest points in making the diagnosis of a diseased appendix The fibrous tissue formation is shown by the irregularity in the contour of the appendix Elongations and dilatations are, of course, present fluoroscopically and otherwise Clubbing, fixation, and all of these diverse points that Dr Deaver found in the 740 cases, are simple procedures to demonstrate roentgenographically

Dr Bell says that he cared nothing about x-rays—he later says it was because he could not rely upon his interpretations The only advice that we could give to one in that state of mind would be to consult somebody on whom he could rely I am strongly of the opinion that no examination of a chronic appendix is proper without a complete gastro-

intestinal study, barium by mouth, followed all the way through

We owe a double obligation in examining any patient, and that is to make the diagnosis, or assist in it, and then see that the patient, if it lies within our power to do so, follows the proper course I find that, when I examine a patient and feel convinced that he has a chronic appendix, it is far easier for me with my consultant to show that patient the condition and lead him to the operating room, than it would be if I talked to him on clinical symptoms all day long

DR BELL (closing) Dr Graham has emphasized the functional basis of this type of examination It is because of this basis that I believe it is of real value Post-operative results have been gratifying in the large majority of cases that could be followed However, in two, although there has been some improvement, many of the symptoms are still present In both of these cases there was a large element of worry and nervousness Generalized irritability of the colon, which seemed more marked in the proximal third was present in both

Dr Sante described his procedure in examination of the appendix I purposely have based my diagnosis largely, if not entirely, on the behavior of the cecum in this group of cases in order to determine its reliability However, I believe the examiner should make use of all methods insofar as they have proven reliable At the present time, I give barium by mouth 12 hours before examining the colon, as above described, and in my examination I observe with the fluoroscope the filling of the cecum, its general appearance, etc If the appendix is filled, I note its position, mobility, type of filling, and determine if localized tenderness is present In some cases the patient is examined later to determine the emptying time I do not wish to give the impression that I believe that, by this examination, one can say which case should come to operation and which should not I do believe, however, that an intelligent use of it will aid materially in determining in which cases satisfactory post-operative results may be anticipated

8 per cent over a range of half value layers in copper from 0.1 to 2.5 millimeters

The ionization currents were measured by means of the vacuum tube measuring device regularly used at Memorial Hospital, described elsewhere (6)

The filters used, together with the intensities of radiation transmitted by them, are listed in Table I. Radiation intensities have been given throughout this paper in terms of electrostatic units per second read on the measuring instrument, rather than in roentgens, because of the uncertainty which still attends the measurement in roentgens of very soft radiation, such as will be found in the depth of the water phantom, even with fairly heavy initial filtration. This will make no difference in any of the conclusions reached, since they are concerned with comparisons only, not with absolute values. The second and fourth columns in Table I give the actual values of the ionization currents in air and on the surface of the water phantom (chamber half submerged). The third and fifth columns give the relative amounts of radiation transmitted by the various filters, on a basis of that from 0.55 mm of copper as 100 per cent. It is evident that these relative values are not influenced by the scattered radiation at the surface of the phantom. That is, for the qualities of radiation used in the experiment, the back-scatter is the same for all (see last column of the table). From this it is evident that the value for the intensity of radiation at the center of a 100 sq cm field on the surface of the phantom may be found from that in air by multiplying the latter by 1.266, for radiations within the quality range of these experiments, as given by a chamber of the type used in this work.

In Table II are given the percentage depth intensities, for each radiation, in terms of its value at the surface. There is no means here of relating actual amounts of radiation—this table supplies only *relative* depth in-

tensities.<sup>2</sup> It is seen that in every case, except for 8.6 mm of aluminium, the radiation at 1 cm depth, or when the chamber is just barely more than completely submerged, varies from that on the surface by only 1 or 2 per cent. At a depth of 3 cm, the variation in intensity is only 4 per cent between the highest and the lowest values, showing no advantage for the heavier filters. This is due to the fact that the variation in intensity is caused partly by absorption of the radiation by the water and partly by scattering. For small depths, the scattering effect is predominant, and it has been shown that it is the same for all the qualities of radiation used in the experiment. As the depth increases, it is to be expected that the absorption effect will become more pronounced, giving higher intensities for the more heavily filtered radiations. This is, in fact, noticeable at a depth of 5 cm, and increases with increasing depth. The differences for different filters, however, are never very great. At a depth of 10 cm, an increase in filter from 0.5 to 2.16 mm of copper has increased the intensity by only 6 per cent, and from 0.5 to 4.4 mm of copper by only 15 per cent. With regard to the use of aluminium secondary filters, it would seem that, in the case of copper primary filters, they are of little assistance in increasing the depth dose. However, it must be remembered that the ionization chamber used had a wall of more than 1 mm of celluloid, and this would absorb any *very* soft secondary radiation from the copper reaching the surface of the water, so that it would not register in the ionization current. As a matter of fact, there is such a soft radiation from copper, capable of traversing 15 cm of air, but absorbed completely in about 1 mm of tissue. Therefore, if the filter is within 15 cm of the skin, this radiation must be removed, otherwise it will contribute to the production of

<sup>2</sup>Depth doses are of course, proportional to depth intensities for a given amount of radiation on the surface

copper the best filter material, but it had several practical advantages. It could be readily obtained in a pure state, so that there would be no question of impurities in the metal affecting the quality or quantity of radiation transmitted by a given filter. It could be rolled into sheets of uniform thickness, and the layer necessary to effect the desired filtration was neither so thick as to be unwieldy nor so thin that it had to be handled with especial care. In 1923, Erskine and Smith made a study of a large number of materials (3). They determined the thicknesses of these substances which transmitted equal amounts of radiation in air, and then measured the absorption of the beams in water. Their conclusion was that elements of intermediate atomic weight were better than those of either higher or lower value. Copper, nickel, and zinc were grouped closely, and were considerably better than gold, which fell almost into the class with water and paraffin. Tin occupied an anomalous position, agreeing with gold for small depths of water but approaching copper for greater depths. These authors did not make a detailed study of different thicknesses of their filter materials.

In 1928, Thoraeus made the observation that it is always uneconomical to use thick filters (4). For a given average quality of transmitted radiation, a greater quantity will be delivered by a thinner layer of a heavier element. He has developed a combination filter consisting of 0.4 mm of tin plus 0.25 mm of copper plus 1 mm of aluminium, which he finds very efficient. He claims for it a considerably higher transmission (surface dose) than for 2 mm of copper with a slightly higher percentage depth dose. This would show it to be a very economical filter for practical use, when radiation of this quality is desired. About the same time, Lenz advocated a filter of 0.5 mm of silver to replace 2 mm of copper. He found that the two gave almost identical surface doses,

but that the silver filter delivered a somewhat greater depth dose.

In view of the relatively small amount of practical data available on filters, it seemed advisable to investigate the surface and depth doses obtainable when a number of different ones are used under conditions comparable to those used in therapy.

These doses depend on the target-skin distance, and on the irradiated area, as well as on the filter. It has been shown, however, that, for practical purposes, these effects are independent of each other (2). The effect of distance, for those greater than 50 cm, may be calculated by means of the inverse square law, for any filter and field. The effect of the size of the field has been carefully investigated and reported in the paper just referred to. By means of data tabulated in this paper, the change in depth dose with irradiated area may be calculated for any filter and distance. Experiments completed within the last few months have corroborated these findings (5). Accordingly the present investigation has been made for one target-skin distance, 50 cm, and one irradiated area, 100 square centimeters.

The x-rays used were supplied by a water-cooled Coolidge tube, operating at 200 K V and 30 ma, on an outfit with a mechanical rectifier. An aluminum water phantom was used, cylindrical in shape, 37 cm in diameter, and 32 cm deep. At no time was the ionization chamber less than 15 cm from the sides and bottom of the phantom. The spherical ionization chamber was of celluloid, about 1 mm in wall thickness, coated on the inside with India ink, to make it conducting. It was 1.8 cm in diameter and was supported on a stem 0.5 cm in diameter. This chamber was calibrated against the standard air chamber over a range of radiation from 100 K V, unfiltered to 200 K V, with 5 mm of copper filter. The total variation was found to be

an erythema, while adding nothing at a depth. In other words, the relative depth dose will be less. In the case of the tin and silver, the secondary radiation is hard enough to penetrate the celluloid chamber,

reason, lead is less efficient as a filter for deep therapy than substances of somewhat lower atomic number.

As for the actual amounts of radiation delivered in a given time, some information

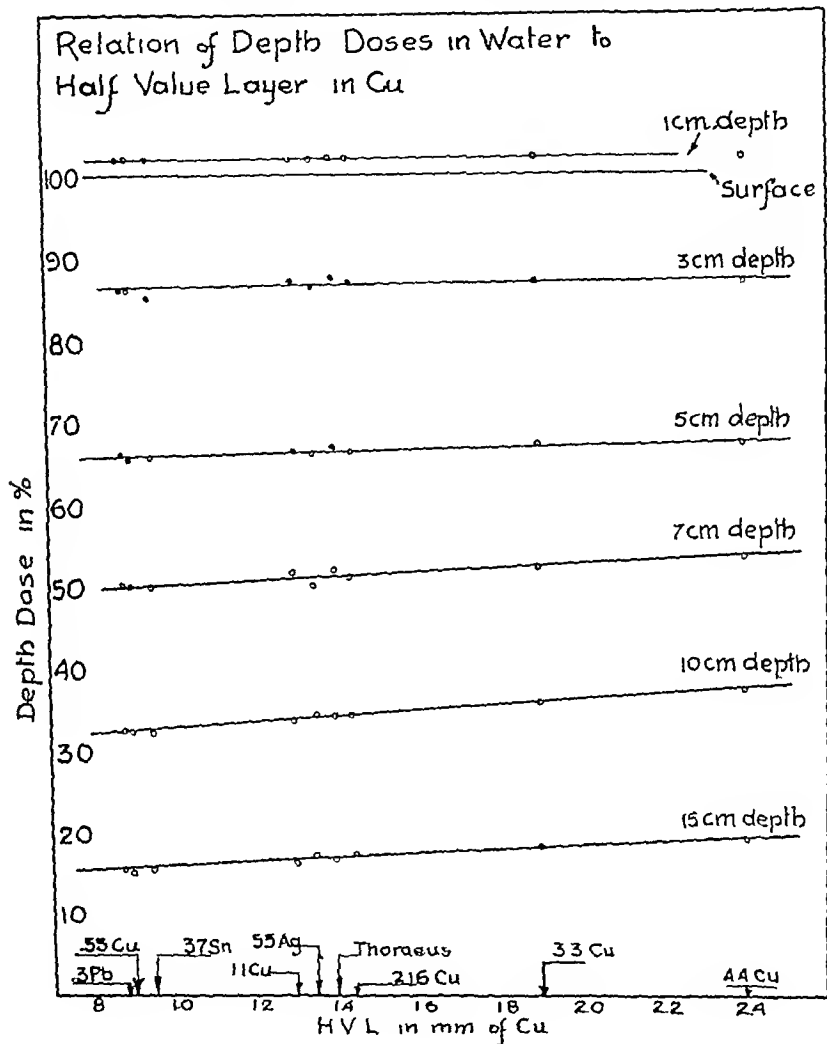


Fig 1

and, accordingly, the aluminum secondary filter shows an advantage. Lead, being a more effective filter for the harder rays than substances of lower atomic number, transmits a beam from which a higher percentage of them have been removed, and which is, therefore, softer, on the average, than for the other filters. Such a beam will deliver smaller relative depth dose. For this

may be obtained from Table III. Here, for a certain group of filters, are listed both the percentages and actual depth intensities. At the beginning is 4.4 mm of copper, and, at the end, 0.55 mm, the extreme filters used. Between these are listed five which give approximately the same depth intensities as 2 mm of copper. From these data it is evident that, for a very small increase in in-

TABLE I—AMOUNTS OF RADIATION TRANSMITTED BY VARIOUS FILTERS  
200 K V, 50 CM TARGET-SURFACE DISTANCE 100 SQ CM FIELD

Filter  mm metal	Amount of radiation				Back scatter  Percentage
	In air		In phantom (chamber half submerged)		
	E.S.U	Percentage	E.S.U	Percentage	
44 Cu + 2 Al	0.168	13.1	0.210	13.0	25
44 Cu	0.182	14.2	0.224	13.8	23
2.16 Cu + 2 Al	0.392	30.8	0.500	30.9	28
2.16 Cu	0.430	33.7	0.549	33.9	29
1.10 Cu + 2 Al	0.712	55.5	0.900	55.5	26
1.10 Cu	0.790	61.5	1.008	62.0	28
0.55 Cu + 3 Al	1.050	81.8	1.33	82.0	27
0.55 Cu + 1 Al	1.195	93.0	1.51	93.2	26
0.55 Cu	1.275	100	1.62	100	27
0.45 Pb	0.342	26.8	0.440	27.1	29
0.30 Pb + 2 Al	0.521	40.6	0.678	41.8	29
0.30 Pb	0.598	46.6	0.759	46.7	27
0.74 Sn	0.408	32.0	0.512	31.6	25
0.56 Sn	0.545	42.7	0.682	42.2	25
0.37 Sn + 2 Al	0.676	53.0	0.867	53.5	28
0.37 Sn	0.788	61.8	0.998	61.6	27
Thoraeus	0.619	48.1	0.781	48.3	26
0.5 Ag + 2 Al	0.420	32.7	0.520	32.1	24
0.5 Ag	0.462	35.9	0.579	35.7	25
8.65 Al	1.42	112	1.81	112	27

TABLE II—PERCENTAGE DEPTH DOSES OBTAINED WITH VARIOUS FILTERS  
200 K V, 50 CM TARGET-SURFACE DISTANCE, 100 SQ CM FIELD

Filter  mm metal	Depth—centimeters						
	0*	1	3	5	7	10	15
44 Cu + 2 Al	100		86.3	67.6		36.7	
44 Cu	100	102	87.0	68.3	54.0	37.6	19.6
2.16 Cu + 2 Al	100		87.3	66.0		34.4	
2.16 Cu	100	101	87.3	66.5	51.4	34.6	17.5
1.1 Cu + 2 Al	100		86.5	67.0		34.4	
1.1 Cu	100	102	87.2	66.6	52.0	33.9	16.3
0.55 Cu + 3 Al	100		86.8	67.0		33.1	
0.55 Cu + 1 Al	100		86.8	66.6		33.1	
0.55 Cu	100	101	86.1	65.6	50.1	32.6	15.1
0.45 Pb	100	101	85.8	65.8	51.2	34.5	16.4
0.30 Pb + 2 Al	100		86.8	66.8		33.1	
0.30 Pb	100	102	86.2	66.5	50.4	32.7	15.5
0.74 Sn	100	102	86.5	66.2	52.8	35.8	18.2
0.56 Sn	100	102	86.8	66.8	52.1	35.1	17.2
0.37 Sn + 2 Al	100		86.2	68.2		33.6	
0.37 Sn	100	102	85.0	65.9	50.1	32.3	15.6
Thoraeus	100	102	87.7	67.4	52.5	34.8	16.9
0.5 Ag + 2 Al	100		88.8	68.1		35.6	
0.5 Ag	100	101	86.5	66.4	50.1	34.5	17.2
8.65 Al	100	97	86.6	63.0	47.0	29.8	13.5

\*The ionization chamber was half submerged for 0 depth

a gain of only 6 per cent in the depth dose. For the same gain in depth dose, the Thoriaeus filter will deliver the required surface dose in 21.4 minutes. It is, therefore, much more efficient than 2 mm of copper.

These comparisons are brought out in the first part of Table IV. Here are tabulated the irradiation times necessary to deliver the same quantity of radiation on the surface, for certain selected filters. In administering this dose on the surface, the 4.4 mm copper filter will deliver a 15 per cent greater dose at a depth of 10 cm than the 0.55 mm copper filter, but it will take 8.9 times as long to accomplish it. In this table, again, the superiority of the Thoriaeus filter over others in its own class is brought out.

In contrast with the results shown in the first part of this table are those in the second part. Here are shown the changes in depth dose and irradiation time brought about by changing the target-skin distance. In this case, a 15 per cent increase in the dose at a depth of 10 cm is obtained by increasing the distance from 50 to 85 cm, with an exposure time for the second distance only 2.9 times as long as for the first. It is evident from these results that it is much more efficient to increase depth dose by increasing the target-skin distance than by increasing the filter, for filtrations higher than 0.5 mm of copper.

In all the above discussion, nothing has been said of the possible advantage in cancer therapy of the harder types of radiation. From the point of view of therapy, the problem becomes very much involved at this point. There is some evidence that rays of shorter wave length are more advantageous in some cases. On the other hand, with sufficient increase in filtration to affect materially the quality of the radiation, the time of treatment becomes so great that it cannot be completed at a single sitting. Between treatments there is time for partial recovery in the irradiated tissues. If normal and malignant tissues recover from radiation

effects at the same rate, the effect of this recovery on the course of the disease may be insignificant. On the other hand, if the rates are different, it will have an important bearing on the method of choice for irradiation. The entire problem is outside the scope of this paper, which can deal only with intensities or quantities of radiation as determined by ionization measurements.

Absorption curves were made for the different radiations studied, in copper and aluminium, to see if any method could be found of determining the depth doses from measurements made in air. In Figure 1 is given a scheme whereby the half value layer in copper, as determined in air, and the percentage depth dose, at various depths in water, are related. Each line represents the percentage intensities, at specified depths, for radiations having half value layers as indicated on the horizontal scale. The experimental points for all the copper filters used, together with certain silver, lead, and tin filters, and the Thoriaeus compound, are given. Straight lines fit these very well, the greatest error for any point being less than 3 per cent. Therefore, within a range of half value layers in copper from 0.8 to 2.5 mm, as soon as the half value layer for a given radiation is known, depth doses may be read directly from these curves.

An attempt has been made to compare these values with those in the literature. Unfortunately, few authors give the half value layer for the radiations with which their depth doses were determined. However, no values have been found which disagreed seriously with these, if measurements were made with small "air-wall," graphite, or horn chambers. (Photographic measurements give uniformly higher results.) In particular, our own earlier data, and those given by Glocker and Kaupp, Grebe and Nitzge, Sievert, and Thoriaeus, agree within a few per cent with the values obtained from these curves (2, 7, 8, 9, 4).

It is evident, therefore, that this chart



TABLE III—COMPARISON OF AMOUNTS OF RADIATION DELIVERED AT VARIOUS DEPTHS WITH DIFFERENT INITIAL FILTRATIONS  
200 K V, 50 CM TARGET-SURFACE DISTANCE, 100 SQ CM FIELD

Filter mm metal		Depth—centimeters					
		0*	3	5	7	10	15
4.4 Cu	ESU %	0.224 100	0.195 87.0	0.153 68.3	0.121 54.0	0.084 37.6	0.044 19.6
2.16 Cu	ESU %	0.059 100	0.485 87.3	0.365 66.5	0.282 51.4	0.190 34.6	0.096 17.5
0.45 Pb	ESU %	0.440 100	0.377 85.8	0.294 65.8	0.225 51.2	0.152 34.5	0.072 16.4
0.56 Sn	ESU %	0.682 100	0.592 86.8	0.456 66.8	0.355 52.1	0.240 35.1	0.117 17.2
0.5 Ag	ESU %	0.579 100	0.500 86.5	0.384 66.4	0.290 50.1	0.200 34.5	0.100 17.2
Thoraeus	ESU %	0.781 100	0.685 87.7	0.526 67.4	0.410 52.5	0.272 34.8	0.132 16.9
0.55 Cu	ESU %	1.62 100	1.40 86.1	1.06 65.6	0.810 50.1	0.528 32.6	0.244 15.1

\*For 0 depth the chamber was half submerged

TABLE IV—COMPARISON OF CHANGES IN DEPTH DOSE AND IRRADIATION TIME OBTAINED BY CHANGING FILTER AND BY CHANGING TARGET-SKIN DISTANCE  
200 K V, 100 SQ CM FIELD

Constant distance—50 cm				Constant filter—0.5 mm Cu			
Filter mm metal	ESU at surface	% depth dose 10 cm	Irradiation time for given surface dose	Distance cm	ESU at surface	% depth dose 10 cm	Irradiation time for given surface dose
0.55 Cu	1.62	32.6	1.00	50	1.62	32.6	1.00
2.16 Cu	0.60	34.5	2.70	60	1.12	35.0	1.45
0.5 Ag	0.58	34.5	2.80	70	0.84	36.0	1.94
Thoraeus	0.78	34.5	2.08	85	0.56	37.6	2.90
4.4 Cu	0.18	37.6	8.90	100	0.40	38.8	4.00

tensity of radiation at a depth, a very great decrease occurs at the surface, so that the delivery of a given dose (total quantity) will take very much longer with the higher filters. The data are tabulated in electrostatic units per second. Assume that a total of 1,000 esu is necessary for one erythema dose. With a filter of 0.55 mm copper,

this quantity will be delivered on the surface in 620 seconds, or 10.3 minutes. In this time, 32.6 per cent of an erythema dose will be delivered at a depth of 10 centimeters. With a filter of 2.16 mm of copper, the time necessary to deliver one erythema dose will be 30.5 minutes, or three times as long as for the 0.5 mm filter, with

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- (8) GREBE and NITZGE Tabellen zur Dosierung der Röntgenstrahlen *Strahlentherapie*, 1930, Supp 14
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## STANDARDIZATION OF ROENTGEN DOSAGE BY MEANS OF METHYLENE BLUE<sup>1</sup>

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Section of Biophysics and Cancer Institute, University of Minnesota

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A dilute aqueous solution, containing substances built up from light atoms, has approximately the same absorption and scattering abilities as tissue. Containers filled with the solution of such a substance may be sealed and sent to different places for irradiation and returned to the central laboratory for examination. Such a method would make it easy to obtain reliable standards for the different x-ray machines without very much expense and in the absence of persons with enough training in physics to handle delicate ionization apparatus.

In order that a chemical method for measurements and standardizations of roentgen dosage may become practical, the following requirements must be fulfilled

1 Absorption and scattering of roentgen rays in the medium must approximate that of tissue

2 The chemical change to be measured must have a simple relation to the dose. The same dose must produce the same change at all times

3 The medium must be stable enough so that it may be left for at least some few days before measurements are made

4 The method for determining the amount of change must be relatively simple and should permit determination of the dosage to an accuracy of at least 5 per cent.

5 The medium (solution) should be easy to obtain and reproduce

6 The change needed for measurements must be produced by a reasonable dose

7 A fairly small amount of solution should be sufficient for each exposure

Although a number of pitfalls have to be avoided, we believe these requirements can be fulfilled by a properly prepared solution of methylene blue. It is our intention to describe how we succeeded in overcoming some of the difficulties, how the solutions were prepared and irradiated, and how the measurements were carried out. Some of the details will be omitted as they have already been described in an earlier publication (4)

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis Nov 30-Dec 4 1931

may be used, with reasonable assurance of the accuracy of the data obtained therefrom, for determining depth doses without actually making measurements with a water phantom. For radiation at 200 K V P (sphere gap), 50 cm target-skin distance, 100 sq cm field, the values may be read directly from the chart. For the same voltage, but for other distances and fields, they may be calculated from these by the methods already described. No tests have been made for other voltages. However, for values not very different from 200 K.V., the chart will probably give good approximations to the depth doses.

#### SUMMARY

For 200 K V x-rays, with a 50 cm target-surface distance and an irradiated field of 100 sq cm, the intensity of radiation reaching various depths in a water phantom has been measured, for a wide range of initial filtrations. These filters include a number of thicknesses of copper, tin, and lead, and 0.5 mm of silver, with and without aluminium secondary filters, and the special compound filter of Thoraeus.

Other fields and distances were not used because it has been shown previously that the effects due to these factors are independent of the filter, within the limits used in practice.

The relative amounts of radiation transmitted by the filters were found to be the same, whether measured in air or on the surface of the phantom, showing that the back-scatter at the surface was the same for the qualities of radiation included in this study. It amounts to 26.6 per cent of the intensity of the direct beam.

The intensity of all the radiations at a depth of 1 cm was slightly higher than at the surface. At a depth of 3 cm, it was about 87 per cent of the surface value for all the filters tested. At greater depths, the heavier filters began to show somewhat

higher intensities, but there was no marked gain before a depth of 10 cm had been reached.

Due to the effect of the walls of the ionization chamber, it was impossible to determine quantitatively the advantage of secondary filters of aluminium in increasing the depth doses.

In order to utilize the greater intensities from the higher filters in delivering greater depth doses, it is necessary to use relatively very long irradiation times.

The same gain in depth dose may be obtained by increasing the target-skin distance, with a considerably smaller increase in irradiation time.

The depth dose in water has been correlated with the half value layer of the radiation in copper. A scheme is offered whereby depth doses for any radiation within the range of the experiments may be obtained as soon as the half value layer in copper is known.

In conclusion the authors wish to acknowledge their indebtedness to Dr Failla, who suggested the problem, for his interest and advice during the course of the work. They desire to thank Messrs R. C. Woods and E. F. Moran for assistance in making measurements and calculations. They also wish to thank Dr Lenz for his courtesy in lending them the silver filter.

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A dilute aqueous solution, containing substances built up from light atoms, has approximately the same absorption and scattering abilities as tissue. Containers filled with the solution of such a substance may be sealed and sent to different places for irradiation and returned to the central laboratory for examination. Such a method would make it easy to obtain reliable standards for the different  $\lambda$ -ray machines without very much expense and in the absence of persons with enough training in physics to handle delicate ionization apparatus.

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Although a number of pitfalls have to be avoided, we believe these requirements can be fulfilled by a properly prepared solution of methylene blue. It is our intention to describe how we succeeded in overcoming some of the difficulties, how the solutions were prepared and irradiated, and how the measurements were carried out. Some of the details will be omitted as they have already been described in an earlier publication (4)

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It is necessary to have in mind that the effect of radiation upon the dissolved substance is influenced by the solvent. In all our experiments distilled water was used. It was necessary to use very dilute solutions in order that the change produced by a reasonable amount of radiation could be determined with fair accuracy. After having tried a number of substances, we chose methylene blue as suitable because it was influenced considerably by irradiation and because the color change could be measured simply and quickly by means of a spectrophotometer. Other substances may be found to be more suitable (1), it will, however, undoubtedly be necessary to take the same precautions with them as with methylene blue.

*A Determination of Concentration*—In order to weigh out the methylene blue correctly, it is necessary to recrystallize the commercial U.S.P. product and dry it carefully. About 0.0016 mg per c.c. of water was found to be a suitable concentration for the preliminary measurements. A spectrophotometer was used to determine the absorption curve (1). After it had been found that the maximum absorption was in the red region at a wave length of about 6,700 Å.U. it was considered necessary to measure the absorption at this wave length only, and to use this absorption as a measure of the concentration and of the change due to roentgen irradiation. As a check, the absorption at 5,000 Å.U., at which point the methylene blue transmits light freely, was sometimes also determined. With an absorption tube 10 cm. long the extinction coefficient before irradiation was found to be 0.316. When new solutions were made up, they were always so examined and the concentration determined by the absorption, rather than by the weight of the methylene blue. After a portion of the solution had been irradiated with roentgen rays, its absorption at the above mentioned wavelengths was again measured. Before the method can be used

for standardization, a curve has to be obtained experimentally showing the relation between the dose and the color change, or percentage decomposition.

*B Care of Solution*—Since the color of methylene blue is to some extent affected by exposure to light (especially ultra-violet), it is necessary to keep the solution sealed in light-tight containers until the time comes to make the measurements. If care is taken, the solution will keep for at least several weeks.

For the first series of experiments, each time about thirty cubic centimeters of solution was sealed in a glass container and placed inside the x-ray tube drum at a distance of 65 cm. from the target. No filter was used. The voltage and the current were usually kept at 200 K.V. and 30 ma., respectively.

*C Effect of Impurities*—The first difficulty encountered was due to impurities. We soon found that very minute quantities of organic compounds might have a pronounced effect on the amount of methylene blue changed. Small amounts, one at a time, of the following substances were then added: Ethyl alcohol, acetone, phenol, sucrose, and calcium chloride. All of them, with the exception of the inorganic compound, calcium chloride, had a pronounced effect in that they reduced the change produced by the radiation. This proves that extreme care must be taken in order that no organic impurities accidentally get into the solution before it has been exposed to roentgen rays (4).

*D Influence of Hydrogen Ion Concentration*—When impurities and exposure to light were guarded against, we found that very good agreement could be obtained in a series of measurements. Two such series with solutions made up on different occasions did not, however, agree with one another. This led us to suspect that the sensitivity may depend upon the hydrogen ion concentration, which may have been slightly different in the two series. Portions of a

new solution were made alkaline and acid by means of small amounts of sodium hydroxide and hydrochloric acid, respectively the  $pH$  was calculated from the percentage concentration of the solution. Tubes filled with the different portions were placed side by side inside the x-ray tube stand and irradiated for the same length of time, 22 minutes (Table I)

TABLE I—EFFECT ON SENSITIVITY BY ADDITION OF HCl AND NaOH TO THE METHYLENE BLUE SOLUTION (FIG 1)

$pH$ calculated	Added	Percentage change	Photometer reading
11.3	NaOH	84	29.0
10.3	NaOH	74	22.3
5.6	H <sub>2</sub> O	64	16.6
3.3	HCl	51	10.8
2.3	HCl	10	3.1
1.3	HCl	1	1.9

It can be seen that the change produced depends upon the amount of acid or base added, the alkaline solutions being more sensitive. These solutions are, however, also less stable. We, therefore, decided that it was best, at least for a preliminary study, to use a  $pH$  of about 7. In order to keep the  $pH$  constant, it was necessary to use a buffer solution and to measure the hydrogen ion concentration with considerable accuracy. (2) For these measurements, a Bailey type of hydrogen electrode,<sup>2</sup> which is made of gold, was used. Platinum black was deposited upon it by electrolysis in a water solution of platonic chloride. The other half cell was a saturated calomel electrode which was connected with the Bailey cell by means of a saturated potassium chloride liquid junction and agar bridge. The hydrogen for the Bailey cell, which was obtained from a hydrogen pressure tank, was purified by passing it over hot platinized asbestos and through dilute solutions of potassium permanganate, potassium hydroxide, sulphuric acid, and water. The electromotive force was determined by means of a "Queen" potentiometer and the  $pH$  calculated from the

formula  $pH = 16.9 (V - 0.246)$ . An air bath was used to keep the temperature as near constant as possible, no correction was made for barometric pressure or temperature. Sorensen's phosphate buffer with a  $pH$  of 6.8 was used for the solvent. In about 300 cc of boiled distilled water, 2.969 gr of  $Na_2HPO_4 \cdot 2H_2O$  and 2.2695 gr of  $KH_2PO_4$  were dissolved. A calculated quantity of a concentrated methylene blue solution was added and the mixture was made up to 500 cc with boiled distilled water. This gave a concentration of 0.0015 mg methylene blue. The  $pH$  was found to be 6.8.

*E Change of Sensitivity of the Solution with Age*—A new batch of buffered solution was made up and used immediately. The sensitivity was, surprisingly enough, not nearly so great as that of the older solution. Next day it had increased, however, and the question then arose. Could the buffer slowly alter the methylene blue solution in such a way as to increase the sensitivity to x-rays without affecting the color before irradiation? The results of the measurements given in Table II answer this question in the affirmative.

The sensitivity increases rapidly at first and then more slowly, reaching a fairly stable state about seven days after the buffer has been added. In these experiments, the absorption measurements were made immediately after the solution had been irradiated. When we measured these solutions later, it was found that the readings had changed slightly, which was a surprise, as the unbuffered solution had not behaved in this way. The solution became slightly cloudy and showed the Tyndall effect, indicating the formation of colloidal particles. In a few days a definite precipitate had been produced. If this was left undisturbed when the solution was poured into the absorption chamber, the readings came back to the value obtained immediately after the exposure to x-rays.

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TABLE II—CHANGE IN SENSITIVITY WITH AGE OF SOLUTION AFTER ADDITION OF BUFFER

Solution	1	2	3	4	5	8	11	25
A 1 hour	67.5 per cent	71.0	81.0	81.2	81.4	81.5		83.5
A 1 hour		71.0				82.0		
A 30 min	48.0	66.5	65.8	67.0	67.3	67.7	67.8	
B 1 hour	62.5	64.5				68.2		

A—Irradiated one hour inside chamber in dark glass tube

B—Irradiated one hour, 50 cm distance, 0.5 mm copper, plus 1 mm aluminum, filter

The results of two series of measurements when the solution had been irradiated inside the "drum" are shown in Table III and Figure 1. All of the solutions of each one of these series had been irradiated the same day and the measurements were taken immediately after irradiation.

TABLE III—RELATION BETWEEN THE LENGTH OF EXPOSURE OF THE SOLUTION TO X-RAYS AND PERCENTAGE CHANGE OF METHYLENE BLUE SOLUTION KEPT IN GLASS TUBES INSIDE THE X-RAY TUBE STAND DURING EXPOSURE

Time	Irradiated during Treatment Percentage decomposition
11.4 min	20
26 min	39
42.4 min	54
1 hour, 22 min	76
1 hour, 47 min	83
	Continuous Radiation
15 min	25
30 min	43
45 min	55
1 hour	65
1 hour, 30 min	78
2 hours	85
2 hours, 30 min	90
3 hours	93

We used 0.0016 mg methylene blue per cubic centimeter.

*F Experiment with Superlawax*—It is desirable to have the solution surrounded by nothing but organic material, and for that reason the glass tubes should be replaced. In the search for a suitable material for containers, certain celluloid products and other substances were tried. A small piece of the material was put in the solution in one glass tube and the change of the methylene blue produced by a dose of x-rays

compared to that taking place in another tube irradiated at the same time. It was found that kodaloid and cellophane reduced the effect on the methylene blue, whereas paraffin did not seem to have any disturbing influence. Paraffin ought to be a specially suitable material for the reason that cavities can be made in large blocks and filled with the solution, thus an arrangement simulating that used during treatment of a patient may be obtained. As we had some difficulty with the paraffin, particularly on account of the roughness of the surface, we substituted "superlawax" (another oil base), which seemed to work satisfactorily.

A groove 10 cm long, 6 cm wide, and 0.5 cm deep was made in a block of superlawax. It was filled with a buffered solution with 0.0015 mg methylene blue per cubic centimeter. A waxed paper was placed on top and sealed to the block with a little melted wax. The block was then placed under the x-ray tube and surrounded by paraffin so that the scattered radiation was fully utilized, 200 K V, 30 ma, 0.5 mm copper plus 1 mm aluminum filter, 50 cm STD was the technique. Under these conditions a rather intense erythema dose is obtained in 13 minutes. Table IV and Figure 2 give the results obtained from these experiments with solutions more than seven days old, measured immediately after the exposure.

Results with the solution irradiated in superlawax are not very satisfactory. The errors are too great and the problem of reducing them remains to be solved. The experimental values marked by dots and circles in the figure show a considerable spread and fall quite far away from the smooth curve.

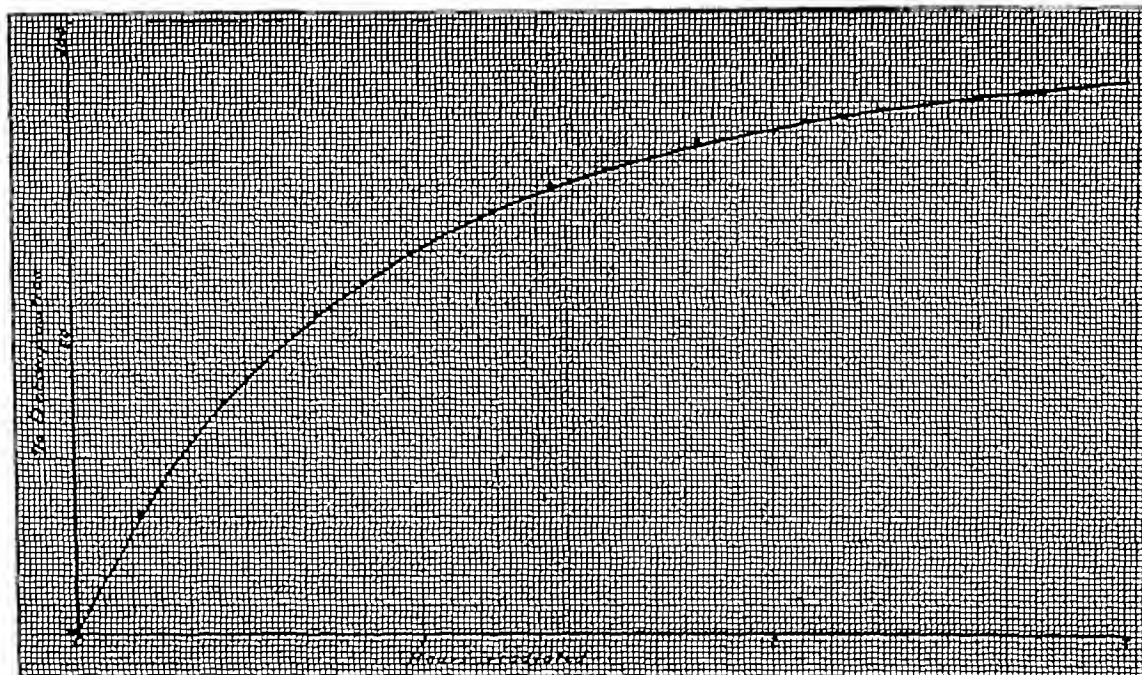


Fig 1 Relation between the length of exposure (in glass) of the solution to x-rays and the percentage changes of methylene blue. Circles refer to first series of experiments, dots refer to second series of experiments

TABLE IV—RELATION BETWEEN THE LENGTH OF EXPOSURE OF THE SOLUTION TO X-RAYS AND PERCENTAGE CHANGE OF METHYLENE BLUE  
Change in superlawax

Time	Reading	Percentage decomposition
15 min	10.7	54
15 min	6.5	37.5
15 min	6.0	40
30 min	12.2	58
30 min	12.1	58
30 min	12.3	58
30 min	11.0	55
45 min	19.2	70.5
1 hour	20.6	72
1 hour	22.2	74
1 hour	23.0	75
1 hour, 15 min	24.0	76.5
1 hour, 30 min	24.0	76.5
1 hour, 30 min	27.3	80.5
1 hour, 30 min	26.4	79.5
1 hour, 45 min	32.6	87
2 hours	34.5	89.5
2 hours	32.1	86.5
2 hours	32.0	86.5

drawn by inspection. The values obtained when the solution was sealed in glass tubes and irradiated inside the x-ray tube stand show much better agreement (Figs 1 and 2).

The solution in the groove of the wax can

also be covered with paraffin and depth exposures made under a paraffin block. We made several such exposures at a depth of 5 centimeters. Naturally two or more solutions can be exposed at different depths simultaneously. The depth dose can be calculated from such a measurement with the help of Figure 2. One hour's exposure at a depth of 5 cm gave a photometer reading of 16, which corresponds to an exposure of 38 minutes at the surface according to the curve. The depth dose at 5 cm, therefore,

$$\text{corresponds to } \frac{38 \times 100}{60} = 63 \text{ per cent}$$

*G Small Containers*—Sometimes it would be advantageous to have small containers with rather thin walls. Glass has usually been used, but the absorption and scattering from the glass contribute to the errors, it would, therefore, be preferable to replace it by organic material, if possible. Such substances as kodaloid and cellophane could easily be made into containers of suit-

TABLE II—CHANGE IN SENSITIVITY WITH AGE OF SOLUTION AFTER ADDITION OF BUFFER

Solution	1	Percentage methylene blue changed (in days)					11	25
A 1 hour	67.5 per cent	71.0	81.0	81.2	81.4	81.5		83.5
A 1 hour		71.0				82.0		
A 30 min.	48.0	66.5	65.8	67.0	67.3	67.7	67.8	
B 1 hour	62.5	64.5				68.2		

A—Irradiated one hour inside chamber in dark glass tube

B—Irradiated one hour, 50 cm distance, 0.5 mm copper, plus 1 mm aluminum, filter

The results of two series of measurements when the solution had been irradiated inside the "drum" are shown in Table III and Figure 1. All of the solutions of each one of these series had been irradiated the same day and the measurements were taken immediately after irradiation.

TABLE III—RELATION BETWEEN THE LENGTH OF EXPOSURE OF THE SOLUTION TO X-RAYS AND PERCENTAGE CHANGE OF METHYLENE BLUE SOLUTION KEPT IN GLASS TUBES INSIDE THE X-RAY TUBE STAND DURING EXPOSURE

Time	Irradiated during Treatment Percentage decomposition
11.4 min	20
26 min	39
42.4 min	54
1 hour, 22 min	76
1 hour, 47 min	83
	Continuous Radiation
15 min	25
30 min	43
45 min	55
1 hour	65
1 hour, 30 min	78
2 hours	85
2 hours, 30 min	90
3 hours	93

We used 0.0016 mg methylene blue per cubic centimeter.

*F Experiment with Superlax.*—It is desirable to have the solution surrounded by nothing but organic material, and for that reason the glass tubes should be replaced. In the search for a suitable material for containers, certain celluloid products and other substances were tried. A small piece of the material was put in the solution in one glass tube and the change of the methylene blue produced by a dose of x-rays

compared to that taking place in another tube irradiated at the same time. It was found that kodaloid and cellophane reduced the effect on the methylene blue, whereas paraffin did not seem to have any disturbing influence. Paraffin ought to be a specially suitable material for the reason that cavities can be made in large blocks and filled with the solution, thus an arrangement simulating that used during treatment of a patient may be obtained. As we had some difficulty with the paraffin, particularly on account of the roughness of the surface, we substituted "superlax" (another oil base), which seemed to work satisfactorily.

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Results with the solution irradiated in superlax are not very satisfactory. The errors are too great and the problem of reducing them remains to be solved. The experimental values marked by dots and circles in the figure show a considerable spread and fall quite far away from the smooth curve.

the patients during treatments and the dose obtained at different locations would be determined. We now need about twenty-five cubic centimeters of solution for measurements, but it seems probable that the amount can be cut down to about two cubic centimeters. Sievert (3) has recently proposed that small ionization chambers, with a charged condenser, might be placed in the tissues during exposure of the patient and the distribution of radiation measured in that way. Possibly solutions could be used in a corresponding way.

*H. Comparison with the Ionization Method*—The measurements reported here must be considered as very preliminary. We wanted to point out the use that may be made of such measurements, and, as similar investigations may be under way at other laboratories, we believe it is of advantage to call attention to the pitfalls which have to be avoided.

The ionization method has been studied rather thoroughly. It is very valuable for measurements of radiation and is particularly suited for maintaining a primary standard. During the last year, Taylor (5) has shown how accurately measurements may be repeated with a standard air chamber and how well they may be reproduced with other chambers constructed in accord with the essential specifications. The standard air chambers give us information about the intensity of the radiation in a narrow beam of rays passing directly from the target through the diaphragms into the chamber. Rays coming from other portions of the tube and other objects are carefully avoided. These chambers, therefore, are not designed to give the average radiation intensity at a certain area of the skin during treatments. Other types of ionization chambers have been constructed for this purpose, which have also been very useful, but it is as yet a question of how accurately they register the dose given to the tissues. Certainly in order to be reliable they must be

handled with particular care and nobody without a considerable amount of training can obtain satisfactory results with them. Aqueous solutions of substances such as methylene blue can unquestionably be used to reproduce the treatment conditions very closely. They can be sent out to the different roentgen clinics for irradiation and be returned to the central laboratory for the measurements. The spectrophotometric measurements referred to in this article are very simple to perform after the apparatus is installed. Standardizations carried out in this way should be inexpensive after the method once has been perfected and checked against the standard air chamber. All machines could, therefore, be standardized as often as desired, perhaps every month, and there would be little excuse for not knowing the exact output from the x-ray tube used for treatments.

Another possibility is to expose at the same time solutions placed at several depths (for instance, 5 and 10 cm) and to use these depth measurements as an indication of the penetrability of the rays. This would not give us a physically satisfactory definition of the rays, but it would, after all, give us the information which is of the most value for the treatments. As yet we have not obtained satisfactory agreement between the measurements made with the solution exposed in superlawax, although the values obtained when the solution was exposed in glass tubes are quite satisfactory. It seems therefore, probable that this method could be used for comparison of dosages when the hardnesses of the rays do not differ appreciably. We should prefer to see the superlawax containers used for such comparisons, but this cannot be done unless the factor responsible for the fluctuations can be removed.

The investigations have to be continued and a number of questions have to be answered experimentally before it can be decided if such a method as is discussed here

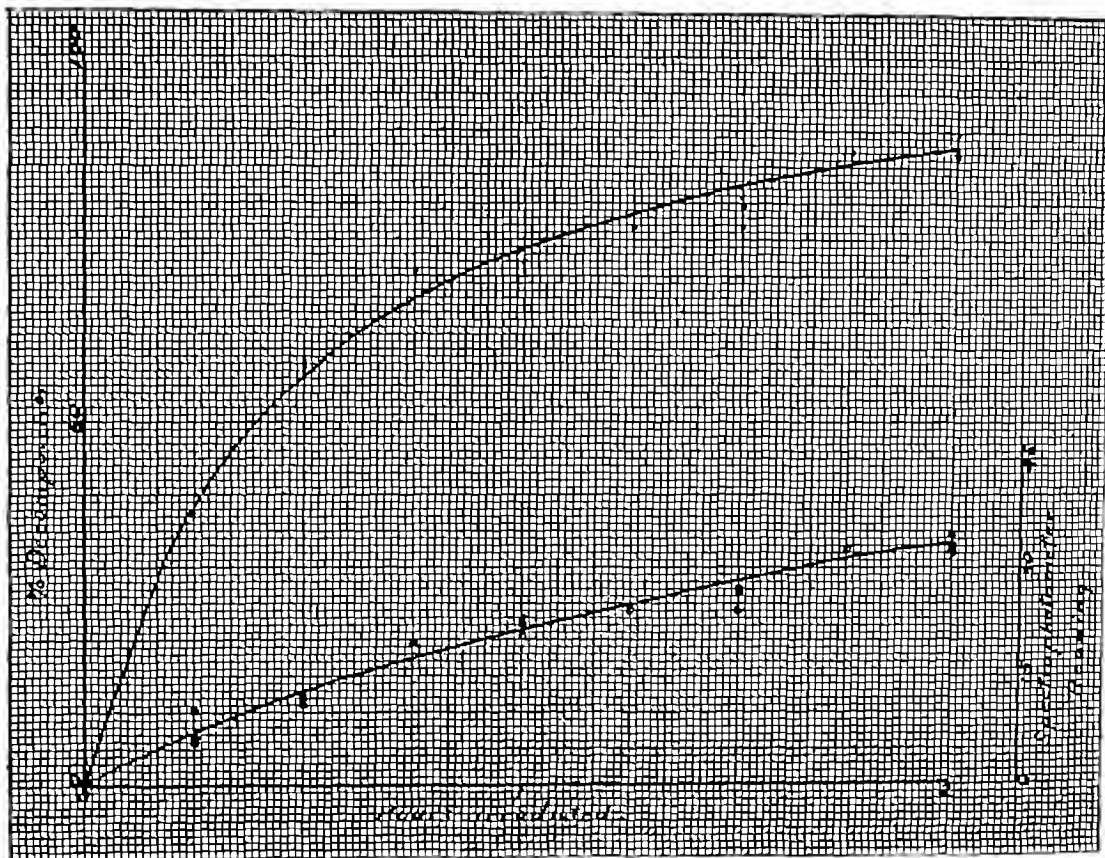


Fig 2 Relation between the length of exposure of the solution to x-rays in superlawax and percentage change of methylene blue (marked by dots) The photometer reading is marked by circles

able size and shape, but they were not considered, as our previous tests indicated that they influenced the change of the methylene blue. Whether this effect was due to the kodakoid and cellophane themselves, or some absorbed impurities, we cannot state for certain, but the effect was there, in spite of the fact that the material was carefully cleaned beforehand. Paralodien is another substance which seemed to offer possibilities. It was dissolved in a mixture of 50 per cent ether and alcohol and the inside walls of some of our original glass tubes were coated with this sticky solution. After the ether and alcohol had evaporated the tubes were washed with cleaning solution and distilled water. The methylene blue was then poured in and exposed to x-rays. The first experiment showed that the change in

the methylene blue was reduced, but further tests showed that the influence on the solution became less marked and disappeared altogether after the tubes had been standing for 15 days and had been cleaned very thoroughly. The effect probably was due to minute amounts of alcohol and ether. It, therefore, seems that paralodien can be used for containers in which the solution can be sealed and exposed to x-rays or  $\gamma$ -rays.

It has been mentioned that the exposure of the methylene blue solution to the amount of radiation corresponding to an erythema dose produces a decided change. It can now be measured with an accuracy of about 10 per cent. A slight increase in the sensitivity would make the method suitable for measuring fractions of an erythema dose. Containers could then be placed in cavities in

# VALUE OF THE FUNCTIONAL GALL-BLADDER (IODEIKON) TEST, AS CHECKED BY OPERATIVE FINDINGS IN 70 CASES<sup>1</sup>

By L. J. CARTER, B.A., M.D., C.M., F.A.C.P., F.A.C.R.  
The Bigelow Clinic, BRANDON, MANITOBA, CANADA

**I**N 1925 at the Annual Meeting of the Manitoba Medical Association in Winnipeg, the author showed a number of X-ray films demonstrating a new method of investigating the gall bladder—the functional method first described by Graham and Cole. Since that time we have used the test in 650 cases, and have reached some very definite conclusions as to its value.

At the onset it should be stated that the iodeikon test does not eliminate the other method of gall-bladder examination. It is supplementary to the barium meal and other clinical methods. It is used only if the history and other findings point to gall-bladder disease.

The iodeikon test is based on the selectivity of the liver for the dye, tetraiodophenolphthalein, which is given orally or intravenously. It is excreted by the liver, and concentrated by the gall bladder in just the same way as bile is excreted by the liver, concentrated by the gall bladder, and stored there for use against the next meal. The test really involves the functional integrity of the liver cells, the bile radicles, the bile ducts, and the gall bladder. In cases of jaundice, the test will not differentiate between liver disease and gall-bladder disease. In practically all other conditions, the diagnosis lies at the gall-bladder end of the tract, here the test is of great value.

## TECHNIC

Following a mild laxative the night before and an evening meal sparse in fats, the dye is given (we prefer by mouth). Immediately before being swallowed 45 gr. are dissolved in distilled water and diluted with

a small bottle of grape juice. It is essential that the dye be fresh, and that it be freshly prepared immediately before each administration. No breakfast is taken the following morning. The first film is made 12 hours after the dye is given, and a second, at 18 hours. Then a meal rich in fats is given (the first food since the dye was ingested), a third film being made one hour after the meal. The first and second films should show the gall bladder filled with the well concentrated dye. The film taken after the meal should show the gall bladder to be reduced about half in size.

We gave the dye in capsule form to the first 215 cases in which we used this test, finding no gall-bladder shadow in 73 cases—34 per cent. But there was considerable difficulty in securing uniform absorption of the dye. Frequently we saw the undissolved capsules in the intestinal tract. In the last 435 cases, we used the dye in the original form, iodeikon, finding no gall-bladder shadow in 123 cases—28 per cent, or an improvement of 6 per cent.

Out of this last series of tests, 70 cases which came to operation have been selected for study. They have been classified as

No gall-bladder shadow

Gall bladder filled and emptied normally

Gall bladder was slow in visualizing and did not show on first or second films

Gall bladder did not empty partly at the post-meal film

Gall bladder filled and emptied normally, but was small or large

Gall bladder filled and emptied normally, but was deformed

Gall bladder filled and emptied normally, but shadow was faint

<sup>1</sup>A clinical presentation before the Annual Meeting of the Manitoba Medical Association at Brandon, Sept. 9, 1931.

can be made practical for the determination of dosage

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### DISCUSSION

DR LAURISTON S TAYLOR (Washington, D C) There is one point that I do not believe Dr Stenstrom has brought out, yet which is of extreme importance in the application of a method of this kind to fundamental problems in the investigation of the distribution of energy beneath the surface of the body, or beneath the surface of a water phantom

This solution that he mentions has very nearly the same effective atomic number as water or body tissue, and, therefore, absorbs the  $\gamma$ -radiation to the same extent One of the very great difficulties in understanding the problem of dosage is brought about by a few apparently arbitrary definitions that we are using the first is the roentgen itself, and the second is depth dosage

In the end it may be that this arbitrariness is not of importance In the meantime what we want to know is how much radiant energy is absorbed at a given point in the medium If, for example, you wish to determine the energy absorption per cubic centimeter of body tissue or water underneath the surface of the water phantom you can not get it exactly by a direct ionization thimble chamber You may be able to obtain it very indirectly The advantage of Dr Stenstrom's method is that if the chemical reaction which he reported is in proportion to the energy absorbed you

may put into the water phantom one cubic centimeter of this methylene blue without disturbing the absorption of the medium as a whole If you put such a cubic centimeter of dye beneath the surface of the water phantom, it is going to absorb the direct and scattered radiation in exactly the same manner as that of the other material in the same place

So it gives us a very direct measure of the actual energy absorption at a particular point That is fundamental in understanding the problem of depth dosage and its relationship to the biologic effect

DR R R NEWELL (San Francisco) Too much emphasis cannot be put on methods which enable us to study the distribution of absorption of  $\gamma$ -ray energy in the tissue or in the phantom without introducing a disturbing substance If you put in a bubble of air it disturbs the distribution in the ionization chamber If you put in anything else, it disturbs the distribution, but, presumably, if we can introduce an organic substance which will respond, we can get the response without disturbing the distribution

DR STENSTROM (closing) I wish to emphasize again that these are only preliminary measurements and, therefore, we can not state as yet exactly what may be expected There are many problems that have to be solved before this method can be made practical For instance, we have to determine if the change in the methylene blue corresponds to the biologic reaction, and if it is proportional to the ionization in the ionization chamber, and a number of other problems All of these have to be solved before such a method as this can become practical

We are not stating that methylene blue is the best to use, though it is the best of the substances we have tried This is just to open a way for investigations of this type If we can find something that is better than methylene blue, it certainly will be of great value I think when we eventually get a chemical method for measurements of dosage, we will be very much better off than we are now

TABLE I—IODEIKON FINDINGS NO GALL-BLADDER SHADOW—28 CASES—  
OPERATIVE FINDINGS

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Yes	Yes		Yes			
Yes	Yes	Yes	Yes			
		Yes			Yes	Whitish-green
	Yes	Yes				Dark
Yes	Yes	Yes	Yes			Gray-green
		Yes				White
Narrow	Yes	Yes	Yes			
Narrow		Yes	Yes			
Yes	Yes					
		Yes				Gray
		Yes				Gray-green
Yes		Yes		Yes		Gray-green
		Yes		Yes		Gray-green
		Yes			Yes	
		Yes	Yes			
Yes	Yes	Yes	Yes	Yes		White
Yes	Yes	Yes	Yes			
		Yes	Yes			Red
	Yes	Yes	Yes			White
	Yes	Yes		Yes		
Yes			Yes			White
Small		Yes	Yes			Gray
Yes		Yes	Yes			Gray
Normal gall bladder						
Normal gall bladder						
Normal gall bladder						
9	11	19	14	4	2	14
Total						73

*Note*—Of the three normal gall bladders which did not show a shadow, one was removed by the surgeons, so we must question its normalcy. This leaves an error of 2 in 28, 7 per cent, a good result for a mechanical test.

TABLE II—IODEIKON FINDINGS GALL BLADDER FILLED AND EMPTIED  
NORMALLY—16 CASES—OPERATIVE FINDINGS

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Yes						Gray-white
Yes					Yes	Gray-green
Normal gall bladder						Green
Yes		Yes				Blue-gray
		Yes	Yes			Green
		Yes				
Yes	Yes	Yes	Yes		Yes	Gray-green
					Yes	White (fat)
					Yes	Pale blue
				Yes	Yes	Gray (fat)
Small	Yes	Yes	Yes			Gray-green
		Yes				
Normal gall bladder						Gray-green
Normal gall bladder						
4	2	6	3	1	4	10
Total						30

emptied normally, but the neck and upper part of the fundus were unfilled, indicating adhesions.

*Operative Findings*—The gall bladder, which was grayish-green, large, and ad-

herent throughout its length to the greater omentum, was removed.

*Iodeikon Findings*—Figure 3 is a 12-hour film of Case 3. The gall bladder filled and emptied normally, but was small and narrow





Fig 1 A 12-hour film of Case 1    Fig 2 A 12-hour film of Case 2    Fig 3 A 12-hour film of Case 3

The operative findings are classified as

Large or small	Deformed
Thickened	Glands
Adhesions	Changes in color
Stones	

Tables I through V classify the cases in groups according to the iodeikon findings, and indicate the operative findings, (1) for each individual case and (2) for each group

Table VI summarizes Tables I through V, indicating the relative importance of the iodeikon findings as determined at operation

#### SUMMARY

As a result of this analysis we draw the following conclusions

1 As a test of gall-bladder disease, a positive finding (1 to 5) (iodeikon abnormality) was correct in 95 per cent of the cases. Of 54 abnormal cases, 51 showed disease at operation. (See Table VI)

2 As a test of gall-bladder disease, a negative finding (6) (iodeikon normal) has no value. Of 16 normal cases, 13 showed disease at operation. (See Table II)

3 As a test of gall-bladder function, the iodeikon test is of the greatest value. Of the 64 diseased gall bladders found at operation, the test showed 23 functioning normally, 15 functioned in a diminished way,

while 26 showed no evidence of functional activity. This should be of great value in determining the question of operation.

4 As an indication of the degree of gall-bladder disease, the most important abnormalities are no shadow, delay, and deformity, since they occur more frequently and have the greatest average number of lesions per case (3). Of lesser importance are faint shadow and change in size of the shadow, since they have fewer average lesions per case (2). (See Table VI)

5 As an aid in visualizing gallstones, the iodeikon method has been a disappointment. Usually the dye obliterates the shadow of a stone which is shown on a plain film. But gallstones are an end-product of gall-bladder disease, and diagnosis, before the stone-forming stage, is needed.

Five illustrative case reports are appended.

*Iodeikon Findings*—Figure 1 is a 12-hour film of Case 1 in which the gall-bladder shadow was faint. At 18 hours, this shadow was much denser. There was deficiency in the concentrating power of the gall bladder.

*Operative Findings*—The gall bladder, which was pale blue with enlarged glands about the neck, was removed.

*Iodeikon Findings*—Figure 2 is a 12-hour film of Case 2. The gall bladder filled and

TABLE I—IODEIKON FINDINGS NO GALL-BLADDER SHADOW—28 CASES—  
OPERATIVE FINDINGS

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Yes	Yes		Yes			
Yes	Yes	Yes	Yes		Yes	Whitish-green
		Yes				Dark
Yes	Yes	Yes	Yes			Gray-green
		Yes				White
Narrow	Yes	Yes	Yes			
Narrow		Yes	Yes			
Yes	Yes					
		Yes				Gray
		Yes				Gray-green
Yes		Yes		Yes		Gray-green
		Yes		Yes		Gray-green
		Yes	Yes		Yes	
		Yes	Yes			
Yes	Yes	Yes	Yes	Yes		White
Yes	Yes	Yes	Yes			Red
		Yes	Yes			White
	Yes	Yes	Yes	Yes		
Yes	Yes	Yes	Yes			White
Small		Yes	Yes			Gray
Yes		Yes	Yes			Gray
Normal gall bladder						
Normal gall bladder						
Normal gall bladder						
9	11	19	14	4	2	14
Total						73

*Note*—Of the three normal gall bladders which did not show a shadow, one was removed by the surgeons, so we must question its normalcy. This leaves an error of 2 in 28, 7 per cent, a good result for a mechanical test.

TABLE II—IODEIKON FINDINGS GALL BLADDER FILLED AND EMPTIED  
NORMALLY—16 CASES—OPERATIVE FINDINGS

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Yes					Yes	Gray-white
Yes						Gray-green
Normal gall bladder						Green
Yes		Yes				Blue-gray
		Yes	Yes			Green
Yes	Yes	Yes	Yes		Yes	Gray-green
		Yes			Yes	White (fat)
						Pale blue
				Yes	Yes	Gray (fat)
Small	Yes	Yes	Yes			Gray-green
		Yes				
Normal gall bladder						Gray-green
Normal gall bladder						
4	2	6	3	1	4	10
Total						30

emptied normally, but the neck and upper part of the fundus were unfilled, indicating adhesions.

*Operative Findings*—The gall bladder, which was grayish-green, large, and ad-

herent throughout its length to the greater omentum, was removed.

*Iodeikon Findings*—Figure 3 is a 12-hour film of Case 3. The gall bladder filled and emptied normally, but was small and narrow

TABLE III—IODEIKON FINDINGS FILLING OR EMPTYING DELAYED, WITH OR WITHOUT DEFORMITY—9 CASES—OPERATIVE FINDINGS

In 6 cases gall bladder did not visualize until one hour after food

In 3 cases gall bladder did not empty at one hour after food

*6 Cases of Delayed Filling*

Small	Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
		Yes		Yes	Yes		White
			Yes	Yes	Yes		Gray-red
Yes			Yes	Yes	Yes		
Yes		Yes	Yes	Yes	Yes		

*3 Cases of Delayed Emptying*

Yes	Yes	Yes	Yes	Yes		
Yes (pouch)	Yes	Yes	Yes	Yes		Gray-white
4	4	4	6	6		3
Total						27

TABLE IV—IODEIKON FINDINGS GALL BLADDER FILLED AND EMPTIED NORMALLY, BUT WAS SMALL OR LARGE—5 CASES

Small	Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Small		Yes	Yes	Yes	Yes		White
Large					Yes		White-gray
Large							Gray green
Normal gall bladder							Gray red
		1	1	1	2		4
Total							11

TABLE V—OPERATIVE FINDINGS

(A) Gall bladder filled and emptied normally, but was deformed—6 cases

Long	Size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
			Yes		Yes	Yes	(Fat)
			Yes		Yes		Gray (fat)
			Yes		Yes	Yes	Gray green
			Yes		Yes		
			Yes		Yes		
1			6		6	2	3
Total							18

(B) Gall bladder filled and emptied normally, but the shadow was faint—6 cases

Large		Yes			Yes	Yes	White
		Yes					Gray-green
		Yes					
		Yes					White
1		5			1	1	3
Total							11

*Operative Findings*—The gall bladder, which was grayish in color and small, but free, was removed

*Iodeikon Findings*—Figure 4 is an 18-hour film of Case 4. It shows a small deformed gall bladder lying below a large



Fig 4 An 18-hour film of Case 4

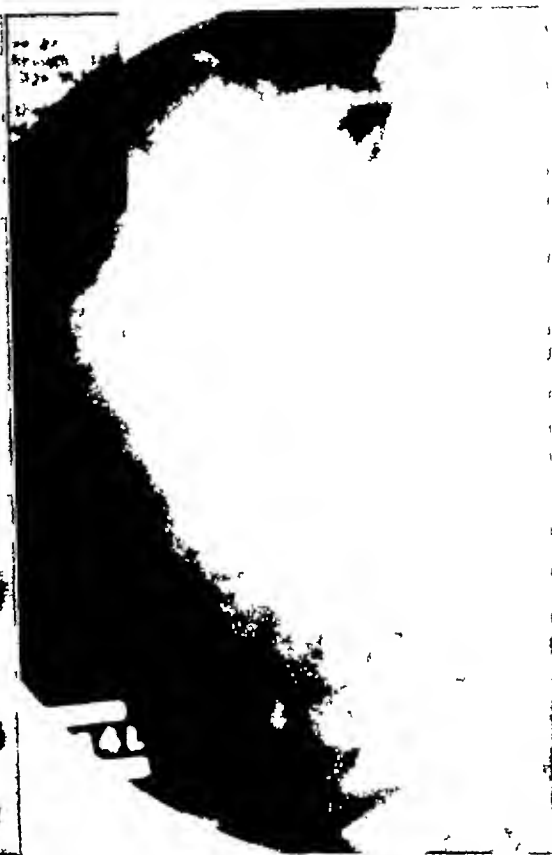


Fig 5 Film of Case 5, made one hour after the fatty meal

calcified cyst The gall bladder filled and emptied normally

*Operative Findings*—The gall bladder was adherent throughout its length to the greater omentum The right lobe of the liver was displaced by a large, irregular, inoperable cyst, which was calcified and palpated like a shell The gall bladder was removed

*Iodeikon Findings*—Figure 5 is a film of Case 5, taken one hour after the fatty meal

was given The 12-hour film did not show the gall bladder The 18-hour film showed the gall bladder with the negative stones outlined by the small amount of dye which had entered Figure 5 shows that the gall bladder is not emptying It lies to the right of the fourth lumbar vertebra

This patient was not operated on It is one of the rare cases in which the iodeikon showed the negative gall stones

TABLE VI—VALUE OF IODEIKON TEST AS CHECKED BY OPERATION

Findings (iodeikon)		Findings (operative)		
		Diseased	Lesions found	Average lesions in each case
1 No shadow	28 cases	26	73	3
2 Delay	9 cases	9	27	3
3 Deformed	6 cases	6	18	3
4 Faint shadow	6 cases	6	11	2
5 Small or large	5 cases	4	11	2
	54 cases	51		
6 Normal	16 cases	13	30	2

TABLE III—IODEIKON FINDINGS FILLING OR EMPTYING DELAYED, WITH OR WITHOUT DEFORMITY—9 CASES—OPERATIVE FINDINGS

In 6 cases gall bladder did not visualize until one hour after food

In 3 cases gall bladder did not empty at one hour after food

*6 Cases of Delayed Filling*

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Small	Yes	Yes	Yes	Yes		White
		Yes	Yes	Yes		Gray-red
Yes	Yes	Yes	Yes	Yes		
Yes		Yes	Yes	Yes		

*3 Cases of Delayed Emptying*

Yes	Yes	Yes	Yes	Yes		Gray white
Yes (pouch)	Yes	Yes	Yes	Yes		
				Yes		
4	4	4	6	6		3
Total						27

TABLE IV—IODEIKON FINDINGS GALL BLADDER FILLED AND EMPTIED NORMALLY, BUT WAS SMALL OR LARGE—5 CASES

Large size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
Small	Yes	Yes	Yes	Yes		White
Small				Yes		White-gray
Large						Gray-green
Large						Gray-red
Normal gall bladder						
	1	1	1	2		4
Total						11

TABLE V—OPERATIVE FINDINGS

(A) Gall bladder filled and emptied normally, but was deformed—6 cases

Long	Size	Thickened	Adhesions	Stones	Deformed	Glands	Color changes
			Yes		Yes	Yes	(Fat)
			Yes		Yes		Gray (fat)
			Yes		Yes	Yes	Gray green
			Yes		Yes		
			Yes		Yes		
			Yes		Yes		
1			6		6	2	3
Total							18

(B) Gall bladder filled and emptied normally, but the shadow was faint—6 cases

Large		Yes		Yes	Yes	White
		Yes				Gray-green
		Yes				
		Yes				
		Yes				White
1		5		1	1	3
Total						11

*Operative Findings*—The gall bladder, which was grayish in color and small, but free, was removed

*Iodeikon Findings*—Figure 4 is an 18-hour film of Case 4. It shows a small deformed gall bladder lying below a large

millimeter of aluminum inserted as a filter. The distance from the target of the tube to the surface of the exposed ovary was 9 inches. The time of exposure was varied as indicated in the different series of experiments. Under the conditions stated, the output of rays from our apparatus as measured in air with a Victoreen dosimeter was 71 r per minute. Because of the extremely small field or block of tissue exposed, correction factors for the effect of scattered rays or secondary rays from the lead-impregnated rubber used in protecting the remainder of the body were not obtainable.

The animals were killed at varying periods after irradiation. Both ovaries were placed at once in Zenker's fixative solution and were later embedded in paraffin and sectioned serially. The hematoxylin and eosin stain was used.

Five series of experiments were conducted in which the conditions of irradiation were identical except for the duration of exposures, which were three, five, ten, fifteen, and thirty minutes for each series, respectively.

*Series 1*—The left ovary of six gophers was irradiated in the early Summer of 1931 with a three-minute exposure (intensity 213 r). These animals were killed twenty-four hours and four, seven, thirteen, twenty, and fifty-eight days after irradiation, respectively. In only one experiment was there a distinct difference in the irradiated and non-irradiated ovaries. Although many young healthy follicles were present in the left ovary the number was greatly reduced in comparison with the right ovary, and there was a corresponding increase in remnants of degenerated follicles. It is unlikely that this difference can be attributed to the effects of irradiation inasmuch as in the second series of animals in which the left ovary was exposed to irradiation for five minutes, noteworthy difference was constantly absent in irradiated and control ovaries.

*Series 2*—The left ovary of ten gophers

was exposed to irradiation for five minutes (intensity 355 r). The animals were killed at varying intervals of from one to sixty-five days after irradiation, respectively, comparison of the right and left ovaries failed to establish any recognizable alteration resulting from the irradiation. The number and size of the developing follicles were strictly comparable in both ovaries and were normal for the corresponding seasonal development for the species. The corpora lutea and ovarian stroma were entirely unaffected by irradiation, not only in these series but also in all the later experiments in which more intensive irradiation was applied.

*Series 3*—The left ovary of eleven gophers was exposed to irradiation for ten minutes (intensity 710 r). The animals were killed at varying periods from the second to the one hundred twenty-ninth day after irradiation, respectively. No effect of the irradiation was noted in the animals killed on the second, third, fourth, and seventh days after irradiation, there was, however, a marked difference in the ovaries of a gopher killed on the twelfth day. The right ovary was in a stage of active follicular development, the cortical rim being crowded with primary follicles and primordial cells, interspersed with intermediate and many maturing follicles. The left ovary exhibited generalized follicular degeneration of apparently rather recent origin, as the structural identity of the cells had not been lost, although the cell borders were indistinct, and the nuclei were absent or pyknotic. In some of the larger follicles there was partial fusion of the follicular contents into the characteristic eosinophilic amorphous mass which marks the old atretic follicle, in others, the zona pellucida of the ova cell was markedly thickened and deeply stained. However, primary follicles and primordial cells remained which, although rather poorly stained, had normal nuclei and an evenly granular protoplasm. A similar picture was

# EFFECT OF IRRADIATION ON THE OVARY OF THE STRIPED GOPHER

(*Spermophilus citellus tridecemlineatus*)<sup>1</sup>

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IN 1919, Drips (1) called attention to the seasonal predominance of certain structures in the ovary of the striped gopher (*Spermophilus citellus tridecemlineatus*). The spermophile has one annual period of rut which immediately follows hibernation. At this time the ovaries are filled with numerous mature graafian follicles, together with a proportion of early or immature follicles. With fecundation, the corpora lutea develop enormously and are the predominating structures within the organ, in addition, usually there is only a framework of the ovarian stroma and a few atretic follicles. Degeneration of the corpora lutea begins in the late summer, and during the autumn the primary follicles grow rapidly to the stage of fully mature graafian follicles. In view of the constancy of these seasonal variations, it occurred to me that this species of animal might be particularly suitable for the study of the effects of irradiation on the various structures in the ovary, particularly in determining whether stimulation or inhibition of growth of any of its elements could be obtained with irradiation of less intensity than that which would prove destructive.

The animals for study were obtained shortly before they were to be irradiated, for although the striped gopher can survive long periods of captivity one cannot be certain that normal physiologic conditions prevail under such altered conditions of life. They rarely will breed in the laboratory (2).

Groups of gophers were irradiated at various times during the spring and summer months. Except in a few instances when

both ovaries were irradiated, the left ovary only was exposed to the rays. The abdomen was opened under ether anesthesia, the left ovarian pedicle was freed, and the ovary lifted out of the abdominal cavity. Protection was then applied to the entire body of the animal except the exposed ovary and a small portion of the ovarian pedicle. Ether anesthesia was maintained during irradiation to keep the animal from moving, which would disturb the protection and the position of the exposed ovary, and for the subsequent replacement of the ovary and closure of the abdominal incision.

A comparison of the two ovaries after this method of irradiation seemed to offer the best means of determining alterations due to irradiation alone, as well as of establishing for each animal the normal seasonal development at whatever time the ovaries were removed. Whether changes noted in the left ovary can be attributed only to irradiation or whether trauma of exposure and drying of tissue during irradiation is likewise a factor is not known. The frequency of unexplained degenerative changes in the ovary has been repeatedly emphasized. I studied serial sections of a number of ovaries of gophers killed shortly after they were captured besides the non-irradiated right ovaries of the experimental gophers in order to be thoroughly familiar with the normally occurring variations.

A Kelley-Koett moderate voltage roentgen-ray unit with a mechanical transformer and a Coolidge broad focus tube were used for the production of the roentgen rays. The peak voltage was maintained at 100 kilovolts, as measured by a standard sphere gap with 5 milliamperes of current, and 1

<sup>1</sup>Work done in the Division of Experimental Surgery and Pathology, The Mayo Foundation. Submitted for publication July 2, 1932.

the abdominal incision was well healed and the left ovary, although extremely small, was easily identified. The right ovary in this animal was at least six times the size of the left ovary, but was somewhat small in comparison with the normal ovary of the animal captured at this season of the year. Cross-sections of the right ovary disclosed many graafian follicles, a rather high percentage of them disclosed some degenerative stigmas. There were numerous primary and small intermediate follicles and a small percentage of old atretic follicles. The ovary contained two or three small primary follicles in which the cell nucleus of the ova was well preserved, but the cytoplasm was stained irregularly. There were no distinct follicles without ova or any evidence of regenerative or proliferative changes.

*Series 5*—The left ovary of six gophers was exposed to irradiation for thirty minutes (intensity 2,130 r). One animal died from injury within twenty hours after the irradiation and the ovaries were removed shortly afterward. The others were killed in series on the sixth, twentieth, thirty-fourth, and forty-fourth day after irradiation, respectively. No difference could be found in the right and left ovaries removed on the first and sixth days. The fact that in the left ovary of the second animal there were no large graafian follicles is of relatively little significance, as such variation in development of follicles is frequently found at this particular season of the year. One animal was found dead in its cage on the morning of the ninth day after irradiation, and, although postmortem changes had occurred by the time the ovaries were removed, the ovarian pedicle and the ovaries appeared normal grossly, although the adjacent tubes were discolored. On microscopic examination a high proportion of degenerated follicles was noted in both ovaries, most of which were in an intermediate stage of development. The majority of the small and primary follicles appeared uninjured, as did cer-

tain of those of intermediate size. In this instance the left ovary contained more large follicles than did the right ovary, a variation in development to which especial significance cannot be given. Both ovaries were congested with blood, and cross-sections of blood vessels exhibited a high percentage of polymorphonuclear leukocytes, indicating an inflammatory reaction. Of the three remaining gophers killed on the twentieth, thirty-fourth, and forty-fourth day after irradiation, respectively, the right ovary in each was free from infection, and exhibited normal seasonal development of follicles, whereas the left ovaries had undergone almost total follicular atrophy, with a few small follicles persisting in each. The left ovaries were small, the stroma being very dense and containing amorphous or hyalinized remnants of degenerated follicles. Corpora lutea were present in normal stages of involution. Thecal cells were irregularly distributed in the periphery of these ovaries, and whorl-like arrangements suggestive of follicles without ova were only slightly manifest. The blood vessels in the left ovaries had apparently been unaffected by the irradiation.

#### CONCLUSIONS

1 Direct irradiation applied to the ovaries of the striped gopher in intensities of 213 and 355 r failed to produce any recognizable injury to the follicular stroma or alteration in their later growth and development. With intensity of 710 r destruction of almost all of the follicles occurred. Degenerative changes were first noted after a twelve-day interval following irradiation. Many primary follicles and primordial cells survived this irradiation and in a few instances, after a longer interval mature graafian follicles were found, all of which, however, showed some slight stigma of degeneration. Irradiation of an intensity of 1,065 r produced massive follicular destruction noted first on the tenth day after irra-



presented in the case of the gopher killed on the seventeenth day after irradiation, with slightly more advanced degenerative changes in the follicles of the left ovary

Both ovaries of two gophers killed on the twenty-fifth day after irradiation had been exposed to the roentgen rays. The ovaries were found to be much smaller than normal, and on microscopic study the stroma was very dense. Most of the follicles had been destroyed, only a few primordial and intermediate follicles persisting apparently uninjured. A few graafian follicles with slight stigmas of degeneration were found in one ovary. The amorphous eosinophilic masses representative of follicular atresia were greatly increased as compared with sections of non-irradiated ovaries. At times, these masses were still surrounded by an irregular corona of epithelial cells and in a few instances cystic spaces partially filled with amorphous debris and recognizable clumps of chromatin indicated an earlier stage in the process of fusion and atrophy. Corpora lutea were present in the usual stage of involution found at this season in the normal animal. The ovaries of all animals examined subsequently in this series corresponded closely to these two.

*Series 4*—The left ovary of twenty-one gophers was exposed to irradiation for fifteen minutes (intensity 1,065 r). The animals were killed from the third to the one hundred tenth day after irradiation, respectively. On the third and sixth day after irradiation, no noticeable change in the irradiated ovary was detected, but in the animal killed on the tenth day, the left ovary, in contrast to the right, did not exhibit large graafian follicles and the primary and small intermediate follicles exhibited definite stigmas of degeneration such as ova with pyknotic nuclei, and fragmented cytoplasm and disorganized follicular structure. No healthy or intact follicles were found in this ovary although a few primordial cells at the periphery of the ovary appeared to be struc-

turally intact. Similar follicular destruction in the irradiated ovary, with the invariable persistence of a few intact primordial cells or occasional primary or intermediate follicles were found throughout the series from the tenth day after irradiation. A few ovaries contained a larger proportion of surviving follicles and in two animals a few graafian follicles were found as well as the more immature forms, indicating a variation in the susceptibility of individual animals of the same species as well as an obvious difference in vulnerability of the individual follicles. The irradiated ovary of the animals killed at the longer intervals after irradiation was extremely small as compared with the control ovary, the stroma was very dense, although not definitely changed in cellular constituents. There was a slight tendency for persistent thecal cells to arrange themselves in irregular circular formations following the destruction of the epithelial constituents of the follicle. This gave rise to an appearance of cord-like masses or follicles without ova, but was not sufficiently marked in any ovary to be regarded as a characteristic formation of the thecal cells in the irradiated ovary. In no instance was there any evidence of proliferative changes of the stroma or follicular remnants. Throughout the series of experiments the corpora lutea failed to show any effect from the irradiation, directly or as a result of the follicular atrophy. The regression of the corpora lutea continued throughout the summer months as in the normal animal not living in captivity.

To note particularly whether the few surviving primary follicles seen in all the irradiated ovaries were capable of late development, the left ovary of four other gophers was irradiated for fifteen minutes (intensity 1,065 r) in August, 1931, and the animals were killed in April 1932. In three experiments infection of the abdominal wound occurred, and resulted in partial destruction of the left ovary. In the fourth experiment

ing in the recumbent position, as the results are found to be more satisfactory. Films made in this position also show the lungs as more transparent than when they are made in the erect posture. The following conditions, however, militate against the usefulness of roentgenograms made in the recumbent position.

1 The diaphragm rises high in the chest (6), compressing or relaxing the lungs.

2 The heart is enlarged in its transverse diameter (7), encroaching on the lung fields.

3 The sternum moves cephalad (8), and with it the clavicles, encroaching on the apical regions.

It is largely for these reasons that roentgenograms of the chest are routinely prepared in the erect position in spite of the increased radiability of the exposed portions of the lungs in the recumbent position. The objections mentioned do not apply, however, to films made in lateral recumbency.

In lateral decubitus, the circumference of the chest is smaller than in dorsal recumbency, due to the increased weight acting on the recumbent hemithorax, however, the hemithorax under consideration (the upper half of the chest) is larger than in the supine position. The difference in the two sides may be further increased by placing a pillow, or sand bag, under the lower side. Here is a typical measurement, taken at random from records made at our clinic.

Circumference of the chest at level of sixth costal cartilages in quiet inspiration

Standing 89 centimeters

Lying on back 92 centimeters

Lying on left side 91 centimeters

(Upper half measuring 47, lower 44 centimeters)

With use of sand bag, circumference

is 89 centimeters

(Upper half measuring 47.5, lower 41.5 centimeters)

Upon inspection the contraction of the lower side and the enlargement of the upper

side are plainly seen. Over the lower side the lung is compressed, as evidenced by dullness, increased conduction of breath and voice sounds (9), and by displacement of the heart to this side. Over the upper half, there are signs of emphysema in the form of hyperresonance and diminished breath and voice sounds. The diaphragm is pushed up on the lower side by the crowding of the abdominal viscera. On the upper side the subdiaphragmatic pressure sinks, due to the pulling away of the abdominal viscera, allowing the diaphragm to descend into an exaggerated inspiratory position. By means of percussion, Norris (10) finds that in lateral decubitus the edge of the lung on the upper side moves down for from 3 to 4 centimeters.

On roentgen examination, the recumbent lung appears relatively small and airless, while the upper lung is emphysematous. The inflation of the upper lung is favored by the shifting of the heart downward, and by the descent of the upper half of the diaphragm. But even in cases in which the heart and diaphragm are fixed by adhesions, the upper lung assumes increased transparency in lateral decubitus, due to enlargement of the bony thorax. It is believed that there also occurs a slight curvature of the dorsal spine, concavity downward, crowding the ribs in the lower hemithorax, and spreading them on the upper side. In this connection, it is recalled that, in the operation for suppurative pleurisy, surgeons have for generations placed their patients with the good side resting on a pillow, expecting thus to increase the intercostal spaces on the involved side.

#### PATHOLOGIC CONSIDERATIONS

All pathologic processes involving the lungs and pleura are generally associated with a certain degree of atelectasis, dependent upon occlusion of bronchi by secretion and other factors. Such areas of collapse

diation and apparently affecting first the larger follicles. In all the irradiated ovaries a few primary follicles had survived, but in no instance even with observation eight months after irradiation and in the spring of the year, when the impetus to follicular development seems most marked, had these follicles exhibited the usual development. Irradiation with an intensity of 2,130 r resulted in massive follicular degeneration apparent on the ninth day after irradiation, but likewise with the survival of a few structurally intact primary follicles.

2 The corpora lutea, blood vessels, and

ovarian stroma were apparently unaffected by the irradiation.

3 No tendency toward proliferative change or formation of atypical cysts as noted in ovaries of the rat after irradiation was found in the irradiated ovaries of the gopher.

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## THE ADVANTAGES OF THE X-RAY EXAMINATION OF THE CHEST IN LATERAL RECUMBENCY<sup>1</sup>

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**I**N this paper we are interested in the appearance of the upper hemithorax in a film made with the subject reclining on one side. We find the upper half of the chest large, the air content increased, while the normal airless structures and all abnormal deposits are brought out to better advantage than when films are made with the body in other postures.

#### PHYSIOLOGIC CONSIDERATIONS

In the standing and the sitting postures, the human chest is in relative collapse, even during deep inspiration. This perhaps unexpected phenomenon is due to the effect of gravity on the ribs and sternum, the weights of the shoulders and the chest viscera, as well as to the soft parts suspended from the diaphragm and ribs. These weights pull the ribs and sternum downwards, i.e., they resist inspiration. Now, upon assuming the recumbent position, the chest is enlarged because the ribs and sternum rise, as they are relieved from the force of gravity (1).

Measurements of the circumference of the chest show that it increases in every case upon the subject's changing from the erect to the recumbent position (2). This increase in chest capacity results in increased air content of the lung. The vital capacity is diminished (3), and the residual air increased in the recumbent position (4), i.e., the lungs are in relative emphysema in the recumbent position. This relative emphysema can be easily demonstrated by percussing over the liver and heart areas, the areas of dullness, invariably present in the erect posture in the normal individual, decrease or disappear when the subject lies on his back. Norris (5) finds that in the dorsal position the anterior margin of the lung moves downward, being about 2 cm lower than in the erect posture.

On fluoroscopic examination, there is an increased transparency of the lungs in the recumbent position. In the obese or very muscular individual, in whom fluoroscopic examination is unsatisfactory in the erect position we have learned to employ screen-

<sup>1</sup>Published with the permission of the Medical Director of the United States Veterans' Administration who assumes no responsibility for the opinions expressed or the conclusions drawn by the writers.

ture, the chest being in relative collapse, the atelectatic areas frequently obscure the underlying causative pathology. Upon assuming the lateral position, the upper lung becomes inflated and many of the atelectatic areas re-expand, producing a truer picture of the disease process. Tumor masses, cavities, and fluid levels are also brought into better relief.

4. Pleural effusions appear larger in the recumbent hemithorax. If they are small, they may escape roentgenologic visualization except when they are viewed in this position.

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#### GASTRIC MOTILITY AS INFLUENCED BY PARALYSIS OF THE DIAPHRAGM<sup>1</sup>

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UNDER normal conditions the diaphragm produces definite changes to the cardia and the stomach, and is one of the important factors in controlling the opening and closure of the former. Thus during respiratory contraction of the diaphragm the pillars also contract, and, by so doing they produce a milking-down contraction at the cardia (1). This contraction can be felt by the examining finger in-

serted through a gastrostomy into the opening of the gastro-esophageal junction. The terminal phase of this contraction can be seen fluoroscopically (2). When a barium meal is given and the subject is studied in the oblique upright position, one can see at deep inspiration that the barium gathers just above the cardia in the esophagus, much like so-called cardiospasm (Fig 1). This picture persists as long as the diaphragm remains contracted just as soon as the diaphragm relaxes during the expiratory

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis Nov 30-Dec 4 1931. Manuscript received for publication in December 1931.

have been described in pneumonia, pleural effusions, emphysema, abscess of the lung, bronchiectasis, and even acute bronchitis (11) That atelectasis plays an important rôle in pneumonia and tuberculosis (12) is well recognized Bartels (13) accepted it as a necessary state in the development of bronchopneumonia More recently Coryllos and Birnbaum (14) have described, in a convincing manner, the etiologic importance of atelectasis in lobar pneumonia Atelectasis has also been pointed out in cases of pericarditis with effusion, in hypertrophy and dilatation of the heart, and in enlargement of the mediastinal and hilar lymph nodes as observed in tuberculosis, Hodgkin's disease, leukemia (15), and aortic aneurysm (16)

These atelectatic areas, unless dependent on permanent bronchial occlusion, are likely to become inflated in the lateral horizontal position For this reason, frequent changes in posture have been used in pneumonia, and especially in the prevention and treatment of hypostatic pneumonia and massive atelectasis Time-honored methods of resuscitation of the newborn and of the drowned depend for their efficacy on the circumstance that rhythmic changes in posture connote a rhythmic expansion and contraction of the chest

#### PRACTICAL APPLICATIONS

A roentgenogram made in lateral recumbency shows the upper lung expanded more than in any other posture The pleural recesses, collapsed in other postures, are now largely inflated, and portions of the lungs usually obscured by the heart, hilum, mediastinum, and by the dome of the diaphragm, are brought into view The atelectatic areas accompanying pathologic inflammatory or degenerative processes in the lungs and heart may become air-bearing On films made in this position, the underlying pathologic process appears smaller, but better de-

fined Abnormal deposits in the vicinity of the diaphragm or mediastinum, appearing of uncertain location when they are viewed on films made in the erect posture, may be plainly surrounded by lung tissue in lateral recumbency Abscess cavities, small effusions, and hydropneumothoraces which, in the erect posture, may be obscured by atelectatic lung and thickened pleura, may become plainly visible with the increased air content of the horizontal position Fluid levels which are obscured by collapsed lung, or due to the shallowness of the overlying air pocket, become conspicuous in lateral decubitus Likewise lung tumors, which otherwise may be merely suspected, appear well defined on films made in this position Also, air collections appear conspicuously enlarged Air being more expansible than collapsed lung tissue, with the enlargement of the upper hemithorax, the former expands to occupy more space Pleural effusions (without air), on the contrary, appear larger in the dependent hemithorax (17, 18) because they are less compressible than lung tissues

#### CONCLUSIONS

1 With the subject lying on one side, the upper hemithorax is larger than in any other posture The lung is emphysematous in this position, as shown by percussion, auscultation, and roentgen examination The hyperinflation of the lung is due not only to the enlargement of the chest, but also to the shifting of the heart and diaphragm

2 Roentgen examinations of the upper hemithorax show the lung larger and more transparent than it appears in other postures Portions of the lung obscured by the diaphragm and by the mediastinum thus become visible and accessible to examination

3 Most pathologic processes in the lungs are associated with bronchial occlusion and atelectasis In films made in the erect pos-

in the muscle of the stomach and that this gradient is greatest at the lesser curvature near the cardia, with the rate of eleven at the cardia to two at the pars pylorica. He says

"We see that local peculiarities in the muscle, with graded differences in rhythmicity, irritability, tone, and latent period, probably have most to do with directing the peristaltic wave as it travels over the stomach. As in the heart, so here, the waves probably have their origins in the most highly rhythmic and sensitive area. We may say perhaps that the region on the lesser curvature next to the cardia is the pacemaker for the stomach. It must be remembered, however, that the cavities of the heart and stomach are very different. In one, the impulse travels so rapidly that the organ appears to contract as a unit, in the other, a series of waves travel slowly over the sac, gently kneading its contents."

McCrea, McSwiney, Morison, and Stopford (5) have also noticed in cats, rabbits, and dogs that the waves which began near the cardia, spread downward, producing a constriction ring at the upper end of the pars pylorica, then a bulging of the pyloric portion, and finally a concentric contraction ring of that region. This contraction, relaxed as a new wave, arrives at the incisura. These facts demonstrate that a wave initiated in the cardia and fundus is conducted down to the pars pylorica.

One must not lose sight of the fact that many other factors influence gastric motility. The work of Todd and his associates (6) has given us a clearer conception of many factors involved in gastric motility. Such factors as hunger, psychic shock, gastric training, central or peripheral impulses through the vagus or the parasympathetic, secretory activity either normal or pathologic, the application of heat or cold (7), and the quantity as well as the quality of food intake have a great deal to do in stimulating or inhibiting peristalsis. Again, one should remember the intrinsic qualities of



Fig 2 Effect of diaphragmatic contraction on stomach. Note low position of fundus with relative constriction at fundus and dilatation at pars pylorica

gastric muscle, namely, contractility, rhythmicity, and automaticity. Alvarez (4), for instance, has noticed evidence of high automaticity at the upper edge of the pars pylorica. He also describes contractions of a greater amplitude in the pars pylorica than in the fundus. With a cardia, therefore, that has a high gradient of rhythmicity, and which is made to open and close with each inspiration and expiration, what would stop action currents from travelling down towards the pars pylorica and initiate characteristic gastric peristalsis? Moreover, there are definite changes in intragastric tension in the different parts of the stomach during the inspiratory and expiratory phases of diaphragmatic motility. These without a doubt are also likely to produce a sufficient stimulation to aid in or initiate peristalsis.

The question may be asked by skeptics, Why, if the diaphragm controls basically the



Fig 1 Constriction of cardia from the pillars of the diaphragm. Note closure of cardia with filling of esophagus

phase, the cardia also opens and the barium meal runs through into the stomach

The peripheral portion of the diaphragm also has a definite influence on the stomach. When one watches the stomach which is filled with a barium meal, he will notice that as the diaphragm contracts and relaxes, it produces definite changes in the contour and the position of the different parts of the stomach (3). The fundus is pushed down and is definitely constricted with each downward contraction of the diaphragm. Coincident with this constriction and descensus of the fundus we can see a change in the shape of the pyloric portion of the stomach (Fig 2). The changes in contour of the stomach remind one of the changes in the contour of an earthworm as it moves from one place to another. One sees a definite swelling of the forepart while the hind part moves forward and then the forepart becomes thinned out as it progresses. In this connection one may also be reminded of the

effect of pressure on a sausage-shaped rubber balloon in which, when one portion is squeezed the opposite portion is dilated. After a few deep breaths one can see characteristic peristaltic waves originating at the incisura angularis, waves which are noticeable when the stomach is left absolutely alone without any manipulation. One would suspect that the imparted contractions and dilatations of the stomach (originating by means of the contracting and relaxing diaphragm) may have something to do in stimulating gastric peristalsis, if he will analyze what happens when a person is made to swallow a stomach tube. The disagreeableness of this procedure induces nausea and vomiting. When, however, the subject is made to take deep breaths, the nausea disappears in most cases. A similar group of phenomena can be studied fluoroscopically. At times one has a patient who cannot tolerate a barium meal. It will be noticed under such circumstances that the stomach assumes an hourglass shape, the fundus becomes more dilated, and the pars pylorica more contracted. If, now the patient is asked to take a few deep breaths he will no longer complain of nausea, and fluoroscopically one can see a relaxation of the hourglass ring and sooner or later normal peristaltic waves become evident. Although it is folly to assume that the diaphragmatic contractions are entirely instrumental in inducing gastric peristalsis, it is perfectly justifiable to assume that the diaphragm plays an important role in the initiation and maintenance of gastric peristalsis.

Theoretically, when rhythmical contractions and dilatations occur in the stomach, definite stimulative changes must of necessity follow in certain portions of the stomach. It is common knowledge that when a muscle contracts, a difference of electrical potential may result at the two ends. Moreover it has been shown by Alvarez (4) that there is a gradient of rhythmicity

They may be classified under three general headings, namely (1) patients in whom respiration was of the costal type, (2) patients with left phrenicotomy, and (3) patients with right phrenicotomy. Some patients have been studied just before phrenicotomy, one week after operation, and from four to six weeks after operation.

The patients who had a distinctly costal respiration showed little or no rise in the diaphragm after phrenicotomy (Fig 3). The normal diaphragm moved very slightly and only after an unusually deep breath. The paralyzed diaphragm at this instant moved slightly upward when the healthy diaphragm moved downwards. There was usually a poor pillar tone, so that the barium could not be held at the cardia. The stomach was of the long tubular type, with the pars pylorica located down in the pelvis. Very little transmitted constriction was noticed in the stomach during deep inspiration. In this type of patient a phrenicotomy would be hardly of any value because the altered mechanics produced by the paralysis of the diaphragm are not present and, therefore, the operation could not be of any significant benefit to the tuberculous lung.

In the second group we studied patients with left phrenicotomy, showing some paradoxical rise of the left diaphragm. Coincident with the descensus of the right diaphragm there was a rise of the left diaphragm. The pillar tone was fair and the barium remained at the cardia a few seconds during each inspiration. The mobility of the fundus was minimal and it remained usually well ballooned up with a bubble of air. Belching was difficult in these patients. The pars pylorica was seen to swing laterally and obliquely so that the movements reminded one of a pendulum with the fundus remaining stationary (Fig 4). The degree of the altered motility in the stomach depended upon the tone of the right diaphragm. In addition to these lateral movements one also noticed a constriction at the



Fig 4 Left phrenicotomy

pars pylorica, with a definite dilatation of the parts immediately above it. The constriction wave progressed along a "U"-shaped line, one tip being at the pylorus and the other at the incisura.

In the third group of patients, in whom the right diaphragm was paralyzed, there was only a slight deviation from the normal imparted motility in the stomach. The tone in the cardia was normal and the fundus descended with each diaphragmatic contraction (Fig 5). Coincident with this there was a dilatation of the pars pylorica. Because of the rise of the right diaphragm the angle at the cardia became more obtuse, so that, during an attack of coughing, the cardia would open and cause regurgitation of gastric contents. This phenomenon was verified clinically in that these patients complained of a tendency to vomiting during attacks of coughing. This altered angle at the cardia also made the tendency to belching much easier. Under normal conditions (11) when the patient is asked to belch we can notice the left diaphragm go down rapidly and at the same time the right di-





Fig 3 Effect of diaphragmatic relaxation on stomach. Note high position of fundus and relative constriction of pars pylorica

gastric contractions, do we not get any clinical symptoms of gastric disturbance in patients with phrenicotomy or phrenic neurectomy? We hope to show in this paper that compensatory changes in gastric motility occur in such a way that normal contraction waves may still be initiated in spite of the paralysis of the diaphragm. Dr S J Cohen (8) of the gastro-enterology staff of the Municipal Tuberculosis Sanatorium of the City of Chicago, who made secretory studies of these patients before and after phrenicotomy, found no gastric secretory changes resulting from the diaphragmatic paralysis. He says:

'In this series of cases the results of the Ewald meal correspond to those of 1,000 consecutive cases studied similarly at the Chicago Municipal Tuberculosis Sanatorium. In this group 45 per cent showed a hypo-acidity ranging from 6 to 19 per cent of hydrochloric acid. There was a normal secretion in 36 per cent of this group with the gastric juice showing an acidity of 20 to 39 per cent. In 9 per cent

of this group there was a hyperacidity, while in the remaining 10 per cent there was an achylia gastrica. There was no variation, therefore, in the reaction to the Ewald meal before and after phrenicotomy."

#### OBSERVATIONS AND RESULTS

Forty patients from the Sanatorium have been studied. They were all ambulant cases and had had their phrenicotomy from one week to fourteen months previous to observation. A small number of women had a costal respiration throughout and the paralyzed diaphragm did not show any appreciable rise. Our results were fairly constant and depended entirely upon the side on which the paralysis was effected.

The following technic was carried out in all our observations. A concise history was taken, with specific questioning about possibility of gastro-intestinal trouble either before or after phrenicotomy. An Ewald meal was then given and the secretory activity was studied by Dr S J Cohen. A fluoroscopic notation was made of the degree of rise of the diaphragm (9), the presence of normal or paradoxical mobility, and the degree of lung pathology still present. The patient was now placed in an oblique position with the left shoulder against the screen in the manner suggested by R D Carman (10). The barium was now followed down the esophagus and as soon as it reached the cardia the patient was asked to take a deep breath. After the tone of the cardia was studied the reaction of the stomach was noted as it was affected by the contractions of the healthy diaphragm. The patient was then placed in an anteroposterior position and the reaction of the fundus and the pars pylorica was noted. Permanent records of the stomach were obtained at deep inspiration and deep expiration, immediately after ingestion of the barium meal, after two hours and after twenty-four hours.

Our results have been quite constant

They may be classified under three general headings, namely (1) patients in whom respiration was of the costal type, (2) patients with left phrenicotomy, and (3) patients with right phrenicotomy. Some patients have been studied just before phrenicotomy, one week after operation, and from four to six weeks after operation.

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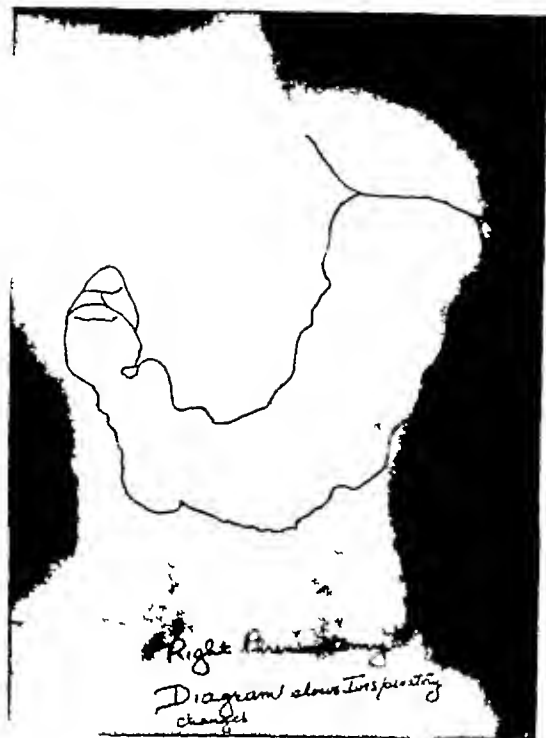


Fig 5 Right phrenicotomy

aphragm go up each time the left side goes down. This is the only instance in which we noticed an independent contraction and relaxation of each diaphragmatic leaf at any one moment. At all other times both sides contract and relax at the same moment. In belching, as the left leaf goes down and the right leaf goes up quickly and repeatedly the cardiac angle becomes less acute and soon the air is seen to find its way through the cardia into the esophagus.

#### DISCUSSION

Theoretically, one would assume that if the diaphragm plays an important role in gastric motility we should expect gastro-intestinal disturbance after phrenicotomy. The absence of such symptoms would lead one to assume that either the diaphragm has no relationship with the gastro-intestinal tract or else that certain compensatory changes have taken place to modify conditions sufficiently to

establish normal function. The latter takes place in paralysis of the diaphragm. Under normal conditions the pillars open and close the cardia with each part of the respiratory phase in diaphragmatic mobility. The peripheral portion of the diaphragm not only pushes the fundus up and down but also aids in the lateral contraction of the fundus, thus reducing its diameter. Coincident with these changes the pars pylorica is modified in shape and diameter. When the diaphragm is paralyzed certain compensatory changes occur. These may be classified under three different groups.

1. The first group of patients is one in whom the diaphragm plays a secondary role in respiration, which is maintained mainly by the movements of the ribs. In this group of costal breathers paralysis of the diaphragm does not induce an improvement in the patient with tuberculosis and produces no change in the motility of the gastro-intestinal tract.

2. In the second group the right diaphragm has been paralyzed, the movements in the fundus are the same as normal, namely, a decensus, with a definite constriction. Coincident with these changes, there is a dilatation of the pars pylorica. There is a slight permanent deviation in the position of the pars pylorica towards the right side. The tendency to belching and vomiting is increased as a result of the relative rise of the right diaphragm and the change in the degree of the cardiac angle from the acute to the obtuse type.

3. In the third group in whom the left diaphragm was paralyzed, the imparted contractions were now transferred to the pars pylorica instead of the fundus and the latter remained more or less immobile. The pars pylorica swings back and forth much like a pendulum. At inspiration it moves laterally and slightly anteriorly. At expiration it moves medially and towards the spine.

Our present findings give us additional proof that the diaphragm plays an important role in influencing gastric peristalsis. The pillars control the opening and closure of the cardia. With each inspiratory contraction of the diaphragm the pillars also contract and close the cardia sufficiently to block the fluid

barium meal from passing through. As soon as the diaphragm relaxes, the cardia opens and the barium runs into the stomach after it bends in an angle of about 90 degrees. The parietal portion of the left diaphragm presses down the fundus during each contraction and in so doing constricts the descended fundus and dilates the pars pylorica. As the diaphragm rises the fundus goes up with it and now the latter dilates while the pars pylorica contracts. In our previous papers (1, 2, 3) we have given evidence to justify our assumption that gastric motility may be definitely influenced by the contractions of the diaphragm. This paper furnishes a further proof of this relationship and incidentally explains altered physiology in gastric motility resulting from paralysis of one or the other leaf of the diaphragm.

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THE SELECTION AND CARE OF THERAPY TUBES<sup>1</sup>

By DANIEL M. CLARK, M.D., SANTA BARBARA, CALIFORNIA

WITH two American and five foreign companies now engaged in the manufacture of therapy tubes, the selection of one which will operate most efficiently and economically under a given set of circumstances may be a confusing and difficult task. Too often the problem resolves into an argument on the relative merits of the various mechanical principles and construction details advocated by different

manufacturers. Unbiased opinions of experienced men are not easy to obtain, simply because their experience is usually confined to one make. The reliability of all the present manufacturers is rather well established, it is, therefore, safe to conclude that the product of any of them, given proper care and operated under the conditions and within the capacity for which it is designed, will give satisfactory service. There are more practical considerations.

Before attempting to select a tube, one

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should know definitely the factors of voltage and milliamperage under which it is to operate. This will be determined by personal preference as to the optimal voltage required and the volume of work to be undertaken. For various reasons, it is desirable to stay as far below the rated capacity as is consistent with the type and quantity of work to be undertaken. No tube will stand frequent or prolonged operation over its rated capacity. It must be remembered that factory tests are carried out under the most favorable conditions. Variations in output of from 10 to 15 per cent have often been demonstrated on two machines of similar type and manufacture under identical factors of voltage and milliamperage (1). It is, therefore, not unwise to select a tube the rated capacity of which is somewhat greater than that under which it is to operate.

The capacity of a tube may be materially reduced by improper cooling and ventilation. On the other hand, it may often be increased by the addition of some simple cooling device, such as an electric fan. Thus, while the factory rating of a certain tube may be 200 K V P, 8 ma, when it is operated in an ordinary lead glass bowl, if it is operated in a closed drum with blower cooling, the same tube may be run continuously at 200 K V P, 10 ma, an increase in output of 20 per cent. Similarly, a certain tube of foreign manufacture, designed to operate at 200 K V P, 4 ma with a water cooling system of the reservoir type, may be safely run at 200 K V P, 8 ma, when a pressure water cooling system is used, an increase in output of 100 per cent (4).

When a tube is kept working in an ordinary lead glass bowl, the cooling conditions are never very good. This is particularly true if the distance between bowl and tube wall is not ample. When the distance is less than 3 cm, the capacity of the tube is materially less than its factory rating.

Most tubes are given a single factory rat-

ing, such as 150 K V P 5 ma, but this does not mean, of course, that the tube cannot be operated under other factors. A tube may safely be run at somewhat higher milliamperage, if the potential is lowered to such an extent that the product of the kilovolt peak and the milliamperage remains constant. A tube with the above rating may, therefore, be operated at 130 K V P 5.8 ma, or 100 K V P 7.5 milliamperage. It is not safe, however, to operate at higher potential than factory rating, even though the milliamperage be correspondingly lowered.

As it is in the purchase of anything else mechanical, factory service is an important consideration. No matter how careful the workmanship and factory testing, it is inevitable that an occasional tube will be defective. Others are broken in transit. Serious difficulties have been encountered in the adjustment of such matters, particularly in the case of some of the foreign manufacturers. The remoteness of the factory, the language difficulty, the limited authority given to American representatives and the difference between American and European business methods may be real obstacles in reaching an agreeable adjustment.

Next to efficiency, the most desirable quality in a tube is economy. This does not mean, of course, that the cheapest tube that will do the work is the most economical. However, in buying what may be termed an "extra-price" tube, one should make certain that the features which make it more expensive will be of value in the particular type of work it is to perform.

For convenience, a chart listing the various therapy tubes offered by one European and both American manufacturers is shown in Table I. The prices, which are quoted for delivery on the Pacific coast, will be slightly less in other parts of the country. It might also be explained that the American purchaser of a tube which sells for \$100.00

TABLE I

Manufacturer	Deep therapy			Superficial therapy		
	Cooling	Capacity	Price	Cooling	Capacity	Price
General Electric X-ray Corp	Water	30 ma at 200 K.V P	450 00	Air	5 ma at 140 K.V P	125 00
	Air	6 ma at 200 K.V P	260 00			
Westinghouse X-ray Co, Inc.	Air	8 ma at 200 K.V P	295 00	Air	5 ma at 150 K.V P	125 00
C H F Müller A-G	Water	180 K.V at 4 ma	480 00	Water	140 K.V at 4 ma	385 00
		200 K.V at 4 ma	590 00		160 K.V at 4 ma	460 00
	Air	180 K.V P at 4 ma.	215 00	Air	160 K.V at 4 ma	180 00
		180 K.V P at 8 ma	265 00		160 K.V at 8 ma.	215 00
		200 K.V P at 4 ma	265 00			

FOB European factory, pays \$40 00 United States import duty, \$4 00 United States customs entry charge, \$15 00 transportation and customs brokers' charge, \$1 45 insurance bonds and notary fees, and \$10 90 import brokers' commission, making a total of \$171 35

Once a tube has been selected and installed for operation, the period of usefulness will be measured to a very great extent by the care it is given. Directions for its proper use and handling should be firmly impressed on all who have occasion to operate it.

External violence is the commonest cause of tube breakage, usually the result of careless handling, such as dropping a tube on the floor or swinging a side arm against the tube stand. The only correct way to carry a tube is with one hand firmly grasping each side arm. Few cases of "dropping" would be reported if strict adherence to this practice were rigidly enforced. The janitor's mopstick or broomhandle has put an end to the usefulness of many a tube. It is, therefore, worthwhile either to remove the tube to a place of security or to run the tube holder to the top of the standard at the end

of the day. Water-cooled tubes are occasionally broken during installation by improper handling, in attaching the tubing for the water system (2). This should be done by a factory representative wherever feasible, or one thoroughly familiar with such work.

When a cold tube is put into operation, the impact of electrons brings about a sudden change of temperature, not only in the target, but, to some extent, throughout the entire tube. In high voltage therapy, therefore, it is essential to build up the voltage over a period of at least three minutes. This is done by starting around 100 K.V P, and gradually increasing until the desired potential is reached. The procedure should always be carried out at the beginning of the day and repeated whenever the period between treatments has been of sufficient time to allow the tube to cool to room temperature (3). In cold weather, it is well to caution technicians and attendants against opening a window in the treatment room while the tube is hot. Uneven cooling, as a result of a sudden draft of cold air, may result in cracking.

Daily inspection of the cooling system of a tube is a sound practice and is most important when pressure water cooling is used. A temporary shutting-off of the water supply will often result in the destruction of the tube. In the reservoir type, small leaks are rather frequent, and, if any water falls on the tube during operation, the result is a punctured tube.

If a tube is operated when it is dirty, not only is the likelihood of puncture increased, but the life will be measurably shortened and the tube is more apt to become gassy. Daily clearing of a tube is, therefore, recommended. This can usually be accomplished with slightly dampened cheesecloth. If necessary, ether or carbon tetrachloride should be used to remove any remaining foreign material. It is hardly necessary to mention that the tube should not be operated until it is thoroughly dry.

Occasionally tube breakage may occur as the result of sparking across between rubber tube supports that have become carbonized (3). This danger may be obviated by periodically replacing rubber tube supports or substituting cork in their stead.

There is a good deal of confusion as to the signs of gas in a tube. Although many regard any flashing or color as due to gas, this is not true. In most instances, color is due simply to fluorescence. Every x-ray tube fluoresces, some considerably more than others, the amount and shade of color varying with the different types of glass used. It is very common to observe color in the anode arm, frequently, the entire bulb will show color. When a tube begins to show color in the cathode arm, however, it is nearing the end of its usefulness. There are two methods of testing a tube for gas. The first and most reliable is the test of operation. If a tube operates successfully up to full capacity and the milliamperage does not show fluctuation then it is not gassy, even though it may show color within its bulb.

A second method, the use of which is limited to the unenclosed types of tubes, is sometimes of value. This consists in looking into the bowl of the tube from an angle, that is, from the cathode or anode end. In the case of fluorescence, it will be observed that the color appears as a thin layer attached to the inner surface of the wall of the tube, whereas, if it is due to gas, the color will appear to be evenly distributed throughout the tube.

Sometimes, when a tube has become gassy, it is possible to operate it at lower voltage and milliamperage so that many useful hours are added to its life. In a case of this kind, the tube should be operated on such factors of voltage and milliamperage that no fluctuation or other disturbance occurs. In rare instances, after a period of operation in this manner, it is possible to return to the original voltage and milliamperage. It is probable that the old practice not recommended by modern manufacturers, of seasoning a new tube by a period of operation at low voltage originated in this manner.

#### SUMMARY

1 The intelligent selection of a therapy tube is based on an understanding of the design and capacities of the products of various manufacturers, an evaluation of their qualities as applied to the particular type of work the tube is to perform, and the conditions under which it is to operate.

2 Economy of operation is possible only through an appreciation of a tube's fragility and through strict enforcement of rules governing its proper care and treatment.

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## DISCUSSION

DR. R. R. NEWELL (San Francisco) Dr. Clark mentioned that fluorescence in the tube does not indicate gas. This is true, Dauvillier, in investigating certain vacuum tubes, especially valve tubes, noted that, the better the vacuum, the more fluorescence is apt to be manifested. Coolidge, at Pasadena last sum-

mer, said that fluorescence might be due to field currents, that is, cold cathode discharges hitting the glass. He projected a piece of the wall of a tube injured by these discharges, showing many fine channels in the glass. It is true that the fluorescence is not due to gas, but it may be important in regard to the life of the tube.

## BRAIN ABSCESS RESULTING FROM AURAL AND SINUS INFECTIONS<sup>1</sup>

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**A**BSCESSES of the brain, arising from infection of the paranasal sinuses or mastoid infection, are usually single, first passing through a stage of septic encephalitis, followed by encapsulation. If the infection of the brain is caused by highly virulent organisms, a rapid necrosis of the brain tissues may follow, and encapsulation does not take place. Treatment of an abscess of this type nearly always fails.

It is the purpose of this paper to discuss some of the important features of brain abscess and to describe a method of treatment which, in the author's hands, has given fairly satisfactory results. It is probable that the technic of operation for brain abscess will be further refined, and that reduction of the present mortality rate will be accomplished by applying different methods of operative treatment to different types of abscess. The size of the abscess, its subcortical depth, and the density of the capsule must all be taken into consideration in deciding whether or not drainage should be employed, and, if used, the selection of the point in the abscess wall into which the drainage material is to be placed. Multiple, metastatic abscesses are not considered, as they are rarely amenable to surgical treatment.

Brain abscesses arising from infection of the frontal sinuses usually develop in the adjacent frontal lobe. Those arising from aural infections are found either in the adjacent temporal lobe or the cerebellar hemisphere of the corresponding side. McEwen found cerebellar abscesses more frequently than those of the cerebral hemispheres. In a series of 31 cases of encapsulated brain abscess, we have recorded only three cases in which the abscess was located in the cerebellum.

While abscesses may result from penetrating wounds of the brain, or even from untreated scalp lacerations without fracture of the skull, it is rare for abscess of the brain to follow a primary acute infection either of the frontal sinuses or of the mastoid. It evidently requires a considerable period for infection to break down the barriers which exist between the inflammation of the bony cavities and the brain. It is generally believed that a transfer of infection from the sinuses, or mastoid, to the brain takes place through the blood vessels which enter the brain adjacent to the infected bone. Infected thrombi form in these vessels, and by retrograde propagation, the infection enters the white substance, in which the blood supply is poor and the level of resistance to infection is low. In this stage, the inflammation of the brain in the region

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual meeting at St. Louis, Nov. 30-Dec. 4, 1931.



of the infected vein is diffuse, but tending to become encapsulated, provided the virulence of the organism is not overwhelming. It is thought that about three weeks are required for the abscess to become encapsulated. During the early stage of abscess formation, that is, during the stage of septic encephalitis, high temperature, chilly feeling, and evidence of systemic sepsis are present. These symptoms may erroneously be attributed to the antecedent infection of the sinuses. However, careful observation will show signs of intracranial involvement persisting, and even increasing, after operation on either the sinuses or mastoid. This is not consistent with uncomplicated infection of these cavities.

While brain abscess is a relatively infrequent result of infection of the paranasal sinuses or mastoid, the proximity of the infection to the brain and the possibility of transfer from the sinus to the brain are good reasons for a careful neurologic examination of every patient who is to be subjected to operation upon these bony cavities. Whether or not there has been an intracranial extension of the infection, should be determined, if possible, before operation.

Competent x-ray examination of the sinuses and skull is an indispensable part of the study of brain abscess. Frontal sinus infection may be accompanied by osteomyelitis of the skull involving the frontal bone. Subdural and encapsulated pialar abscesses are frequent consequences of the bone infection and the bone involvement can be shown only by x-ray study. In one patient of our series, who presented air in the abscess cavity, the condition was diagnosed entirely so. This patient who had a right temporal lobe abscess which was leaking through the mastoid wound, had no signs of intracranial involvement except a homonymous upper quadrant defect in the left visual field.

After encapsulation of the abscess has

taken place, the patient's general condition usually appears to be greatly improved, although he frequently runs a slow pulse and is inclined to be less alert. As the pressure increases, stupor becomes more pronounced, and the patient's expression and conversation are more or less mechanical. If questioned, he complains of almost continuous headache, but, as a rule, he says little about headache unless he is reminded of it. The temperature, which is sometimes high before encapsulation takes place, may range from slightly above the normal to a degree below normal after the capsule has formed. The blood count is rarely elevated, unless a complication, such as extension of the abscess toward the surface of the brain takes place. This so called "latent stage" may show certain focal signs, such as a slight weakness of the lower face on the opposite side. In large abscesses, there may be a definite weakness, or even hemiplegia of the opposite side. In abscesses of the cerebellum, the progress of the case is usually very much more rapid, due to the association of an internal hydrocephalus, caused by blockage of the fluid in the posterior fossa. Choked disc was present in 50 per cent of the 31 cases of our series. Of the three cerebellar cases two had only slight blurring of the discs before operation, whereas in one, the discs were normal.

The stage of abscess encapsulation may vary, sometimes lasting for many months. The condition, then, is one of intracranial pressure, plus certain focal phenomena, due to the location of the abscess. From time to time the patient may have attacks in which there is a sudden exacerbation of the symptoms, sometimes accompanied by a rise of temperature. A break in the abscess wall and the production of a pericapsular encephalitis or edema of the brain produced by the abscess itself may be responsible for these exacerbations. The favorable time for operation is during this latent or sec-

ond, stage There is no chance of benefiting the patient by operation in the first stage, when the brain infection is diffuse In the terminal, or third, stage, the complication of meningitis, or respiratory failure due to medullary compression, has placed the patient beyond the help of surgery The terminal stage is usually due to rupture of the abscess into the ventricle or subarachnoid spaces, with a fulminating meningitis as a result

The main factor in the reduction of mortality in brain abscess has been the selection of the proper time for operation It has been thought by some that the study of the discs might give information as to the best time to drain the abscess, and that progressive choking of the discs indicates the encephalitis has not been controlled According to those who hold this view, operation at such a time gives a high mortality But, when the swelling of the discs becomes stationary, one may believe that the abscess has become encapsulated, and it may be evacuated with less risk If the history and symptoms indicate that encapsulation has taken place, one hesitates to assume the risk of delay in the presence of high intracranial pressure as shown by choked disc, inasmuch as the complication of rupture or medullary compression is always a real danger

In certain cases with an indefinite history of antecedent infection, the diagnosis between abscess and tumor may be very difficult In other cases (more or less rare) difficulty is found in making a localization of a suspected abscess To decide between tumor and abscess, an exploratory puncture through a drill opening may be necessary Ventriculography may, at times, be required Careful neurologic examination with a searching inquiry into the sequence of events following the patient's primary sinus infection will furnish the main elements in the diagnosis of a large majority of cases of brain abscess

#### TREATMENT

When there are reasonable grounds to suspect the existence of a brain abscess, associated with sinus or mastoid disease which has not been operated upon, the question often arises Should the abscess of the brain or the sinus infection be operated upon first, or should both be dealt with at the same operation? In our own cases, if the intracranial involvement indicated brain abscess, and the mastoid or sinus disease was not threatening, we have first operated upon the brain abscess through a clean field, following this by treatment of the sinus or mastoid infection after complete recovery from the brain abscess In abscesses of aural origin located in the temporal lobe, drainage may easily be made through the mastoid wound However, should exploration fail to show an abscess, the patient would be subjected to the risk of meningitis

The method of drainage which we have found satisfactory has been fully described in previous papers Only a brief reference will be made here to the operative technic We have routinely used the eye-end of a soft rubber catheter for drainage, whenever it could be inserted into the abscess cavity without great difficulty In some cases in which the abscess is small and the capsule thick (particularly when the abscess is located at considerable depth), insertion of the catheter into the abscess cavity may be almost impossible without producing extensive trauma to the brain and widespread pericapsular encephalitis To my mind, adequate drainage of the small, densely encapsulated, deeply seated abscess presents the greatest problem in the treatment of brain abscess It may be that simple tapping after Dandy's method, is to be preferred in some of these cases, or complete enucleation of the abscess might be attempted

Drainage is facilitated by placing the tube in the lowest point of the abscess cavity If the first puncture of the ventricular needle

enters the cavity at considerable depth, a second, or even third, puncture may be made in a different location, in order that the drainage tube may pass through the thinnest possible strip of normal cerebral tissue

Death from unoperated brain abscess is generally caused by meningitis or medullary compression. Patients not surviving operation usually die of a septic encephalitis provoked by the surgeon's efforts at drainage, and not from meningitis, as is often stated. It is true that meningitis may be a terminal event in the septic encephalitis, but not the primary result of operation. In cases of virulent infection with rapid necrosis of brain tissue, particularly if the abscess is near the surface, it may be that King's method of "unroofing" would save an occasional patient. The results of operation are best in those cases in which there is a free flow of pus through the tube when it is first inserted. In some the pus is entirely evacuated at the time of operation, and there is little subsequent drainage, except that produced by the tissue reaction caused by pressure of the tube.

The post-operative recovery is not generally a smooth one. Much judgment is required to determine whether or not additional attempts should be made to drain the abscess. We have adopted a very conservative attitude in the treatment of these cases after the first operation. Frequently we have postponed, or even declined altogether, further operation, and we have had no occasion to regret a policy of delay or non-interference. One must remember that the fatal complication is generally septic enceph-

alitis, and that ill-advised surgery traumatizes the brain and spreads the infection, which might otherwise disappear, or become encapsulated.

In our experience, late residuals, such as convulsions, have been very infrequent. Naturally the type of residual would be determined by the location of the abscess. Abscesses of the motor area are likely to cause Jacksonian attacks or even hemiplegia.

The prognosis of brain abscess is good, if operation is performed at a favorable stage. It is possible for absorption of small abscesses to take place without operation, but removal of the abscess by absorption is too rare to be relied upon as a means of relief. The employment of simple methods of drainage has done much to lower the mortality, which was always high when trauma and a spreading encephalitis were added to the encapsulated infection. There is always a certain amount of encephalitis produced by any kind of operation for brain abscess. A fundamental requirement of the successful operation is the eradication of the abscess with minimum trauma and infection of the surrounding brain.

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# THE CANCER PATIENT AND HIS DISEASE<sup>1</sup>

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EVERY cancer patient is a special law unto himself. In each case of cancer there are varying underlying causes which combine to effect the transformation of normal cells into a malignant newgrowth. The predominating causative factor in one person may be due to genetic errors of constitution and heredity. This is strikingly brought out in cases in which the same pathologic lesion attacks several members of the same family, and always the same organ. In another case it can be traced to constant traumatism, from within or without, as the exciting principle to start the disorderly growth. Curiously enough, in the majority of cases, cancer occurs in organs which were formerly quite undisturbed by illness, in individuals who have enjoyed good health until, suddenly, they present signs and symptoms of a malignant tumor.

The lack of fundamental knowledge of natural laws which govern normal growth, and want of information concerning constitutional errors responsible for tissue abnormality, put us at a loss to estimate the underlying cause of the malignant newgrowth. As a result of this, the influence of chief importance in the causation of the disease may vary as between individuals. This is one of the main reasons why malignant disease is essentially of differing biologic significance, and why the fundamental importance of malignant disease should be centered upon the patient himself.

In short, cancer in any two persons presents different entities. For example, the histopathology of two tumors may be alike, yet they may differ widely in their origin, exciting factors, and clinical course. So too, the duration of the lesion is not a reliable index to foretell how long a patient

may live with his malignant disease. Tumors occurring in different parts of the same organ, particularly the uterus, also differ in their virulence. If the lesion involves the cervix, it is highly malignant, if it is situated in the fundus, its malignancy is less virulent and prognosis is much more favorable.

If from these preliminaries it is apparent how difficult it is to estimate the underlying biologic nature of the malignant disease, it becomes increasingly evident that the patient, with his tumor, is of paramount interest. This is best exemplified by two patients, each with a cancer of the breast, of the same size, in the same locality, of the same duration, one in a woman of 55, the other in a pregnant woman of 40. In the withered breast of the woman of 55, retrogressive changes have practically replaced the breast tissue, the organ is functionally passé, hence little lymph flows through it, and metastases to the axillæ will occur comparatively late. On the other hand, in cancer of the breast of the young, pregnant woman, we are dealing with an entirely different effect. Here the breast functions at its optimum, new acini are forming, and in such a breast the activity of the lymph flow is pronounced. Active lymph flow means that early dissemination has taken place, even before suspicion has been aroused that there is a primary lesion in the breast.

In other words, here we have a striking example of how differently malignancy in the breast behaves in two women, and how misleading it is to draw conclusions from statistics based upon dissimilar conditions. Having established the fact that the biologic behavior differs in the cancers of the breast of these two women, are we serving the best interest of the patients if we subject them

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both to the same routine method of treatment? In answer, let me emphasize the significance of my first sentence. Each patient with a cancer is a law unto himself.

The problem of malignancy is, and has been for centuries past, a perplexing and elusive one, notwithstanding the tremendous amount of research carried on by the best minds in the world. It is not my intention to sidetrack the importance of the disease itself, but generalization in cancer does not mean a thing, and the all-important question, which constantly confronts us, remains. What are we to do for the patient who is suffering with his cancer?

In the well conducted cancer clinics, in which each worker is trained in his particular specialty, it is the custom to confer about each cancer patient, and finally to decide upon the best method of procedure. In contrast to this, it is regrettable that the surgeon, who sees cancer with a surgical eye, or the radiologist, or the internist, should take it upon himself to assume the responsibility of pronouncing a judgment involving life or death. There should be no narrow individualism in the treatment of cancer. In every case, the evaluation of the disease and the constitutional study of the patient require the soundest judgment and experience, in addition, an intimate knowledge of the disease, its immediate outcome, and ultimate prognosis. In the vast majority of cases, this is not a one-man job.

Let us stop for a moment to consider. How have we approached the real problem? Most writers stress the pathology of the malignant tumor as it occurs in the various organs, basing their opinion and outlook upon one or the other method of treatment. While this sort of information may be interesting and significant it is limited at best as it leaves out of consideration the constitutional, physiologic, psychic, and other biologic features of the patient with his cancer.

If we now accept that the cancer process

is not one and the same thing in any two cases, and apply this in the accessible and easily recognizable tumors, note how the difficulty increases when we come in contact with the inaccessible and perplexing cancers of the stomach and intestine. These make up practically one-third of all malignant diseases, but, unfortunately, the patient in this group presents himself at the time when the tumor has grown to a size at which it produces symptoms of pressure, ulceration, or hemorrhage. Equally deplorable is the fact that early diagnosis of cancer of the stomach or colon is almost speculative, because rarely do clinical signs or symptoms assert themselves until quite late in the disease.

To digress for a moment, permit me to mention that the notion that cancer incidence is consistent with an age limit of 40 or over has blinded the profession to overlook cancer in persons younger than 40 years. Alvarez reported lately that, in his series of cancer of the gastro-intestinal tract 10 per cent were in individuals under 40 years of age. In a recent publication by the writer it was especially emphasized that cancer does not respect any age limit whatsoever, as a matter of fact it occurs more frequently than is suspected in the young and also in children. Consider that, in a series of nearly two thousand cases of brain tumor reported by Harvey Cushing, 20 per cent were found in the first two decades of life. In his series brain tumors ran parallel in frequency with those of the breast and uterus, or at least very close to them. Moreover, of the renal tumors 20 per cent are recorded in childhood and every type of malignant disease is encountered in the young. To put this in another form there is no age which is immune to cancer.

Continuing the subject of cancers affecting the gastro-intestinal tract, the symptoms of a malignant disease are so vague as to be entirely misleading. Not until the lesion has existed for many months, and pro

duces definite symptoms, is it possible to recognize the presence of a tumor. As has already been indicated, in this group especially, I urge with great force that the patient is to be safeguarded. The surgeon, in his whole-hearted attempt to effect a cure, must keep ever before him "safety first" as his guiding principle. The radical surgical procedure must have in view, besides the removal of the tumor, *efficiency with safety*. Surgery of cancer of the colon is surgery of the lymphatic system of the colon, and it requires an intimate knowledge of the lymphatic anatomy and pathology. Nowhere is this better demonstrated than in cancer of the large intestine. Again, the magnitude of a radical surgical procedure is often beyond the power of the patient's endurance, and in most cases the best possible, or most radical, operation cannot be performed. Very frequently "safety first" demands that a less radical procedure be carried out. Therefore, it happens often enough that a surgeon is compelled to perform that which he knows to be an incomplete, and also imperfect, operation.

An appreciation of these principles represents the starting point of an adequate understanding of the patient and also of the beginning of the malignant process, and its ending.

If we now concede that this group of cancer tests the keenest judgment and experience of the surgeon and specialist, we can well appreciate how much greater are the difficulties in cancers which are inaccessible and inoperable from the start, as, for instance, the cancers of the pharynx, nasopharyngeal region, the esophagus, etc., or in post-operative recurrences and the cases in which surgery is impractical. Since only 20 per cent of the patients present themselves with an early diagnosis or at an operable stage, you will realize that the inoperable group constitutes the majority of patients with whom we come in contact, and yet

comparatively little has been said about them.

It is in this class that, as a last resort, the use of x-rays and radium has awakened the concern of the profession. Because of the hopeless outlook in these patients, the radiologist may well emphasize that 10 per cent have received much benefit from the radio-active substances, and that these agents have achieved here what no other methods of treatment had been able to accomplish. The limited time at my disposal does not permit me to dwell on the value of the x-ray and radium in these cases, but to stress the significance of the patient himself.

First, and foremost, every possible effort should be concentrated upon the patient himself, and what can be done to restore him to a state of health. Secondly, is the method of treatment directed to the tumor a safeguard against a recurrence of the same malignant disease?

If surgery is the method of choice, then a correct estimation is necessary of what the patient can stand at one time. Extensive and mutilating surgical procedures, often with no prospect of a cure, are a disappointing proof of the inadequacy of the method applied. This does not argue against incomplete operation, if its purpose is to relieve the patient of his discomfort or distress. The increase in cancer mortality raises the question of whether or not the present methods of treatment are qualified to cope with the malignant disease.

In accordance with this, there is, at the present time, a better understanding of the ineffectiveness of some of the former methods of treatment. For instance, the tongue is no longer excised when the regional glands are involved, cancer of the cervix is no longer synonymous with the Wertheim operation, and with the Coutard method of treatment of cancer of the larynx the patient is no longer subjected to the multilat-

ing operation of laryngectomy. After all, it is not merely the excision of the tumor, but the patient himself, who has to be reckoned with.

If, for instance, there is a disorder of metabolism or of the internal secretions, whatever therapy is indicated should be given conjointly with the treatment of the growth. This means more attention to stimulation and fortification of the natural defensive mechanism of the patient and less concentration on the direct attack upon the tumor itself. An individual with a badly depleted salt or water metabolism, and increased nitrogen retention, is no subject for surgical interference.

In this respect, it is reprehensible that methods other than surgery and irradiation are rarely mentioned, simply because the merits of any one method are measured by the yardstick of a permanent cure. For this

reason, the clinician has not been seriously concerned with the symptoms of anemias or toxemias, and the use of measures which may help to restore the patient's constitutional resistance, preferring to seek a therapy with vision of a cure.

Thorough clinical efficiency is necessary in the scientific management of the patient. In the face of grave prognosis and hopelessness of the disease, it would add immeasurably to the comfort and happiness of the patient if we instilled cheer and hope during our contacts with him. The physician who thinks only anatomically, chemically, or physiologically cannot understand the man before him, and fails to recognize the forces at work which tend to injure or benefit the patient. As a concluding sentence, permit me to quote Sir Frederick Treves: "In the face of misfortune, it is merciless to blot out hope."

## A CLINICAL AND ROENTGENOLOGIC STUDY OF FACTORS INFLUENCING THE PALPABILITY OF THE LIVER<sup>1</sup>

By C. W. OSGOOD, M.D. and J. E. HABBE, M.D. MILWAUKEE, WISCONSIN  
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### LIVER SIZE

UNTIL recently, but few investigators have attempted to establish normal standards for liver size as determined by radiographic measurements. It has been customary to judge liver enlargement clinically by determining the level at which the liver can be palpated below the costal margin. The original purpose of our study was to test the validity of this practice using X-ray mensuration as a criterion of size. The study was extended to include observations of factors other than liver size possibly influencing palpability. Pfahler (10) in 1926, made a series of 500 anteroposterior abdominal films using a Bucky

technic and centering the rays over the ensiform cartilage. From a selected group of 324 of these, he determined the size of the liver, or, more correctly, the linear measurements of the right lobe of the liver. Two measurements were made, one, the length measurement of the distance from the tip of the right lobe to the farthest point on the dome of the diaphragm, and the other, the thickness measurement obtained by erecting a perpendicular to the inferior margin through the most distant point on the dome of the diaphragm. Moody and Van Nuys (8, 9) made routine postero-anterior and anteroposterior films in a similar study of 1,200 presumably normal young adults at the University of California. In their work, the rays were centered at the level of the

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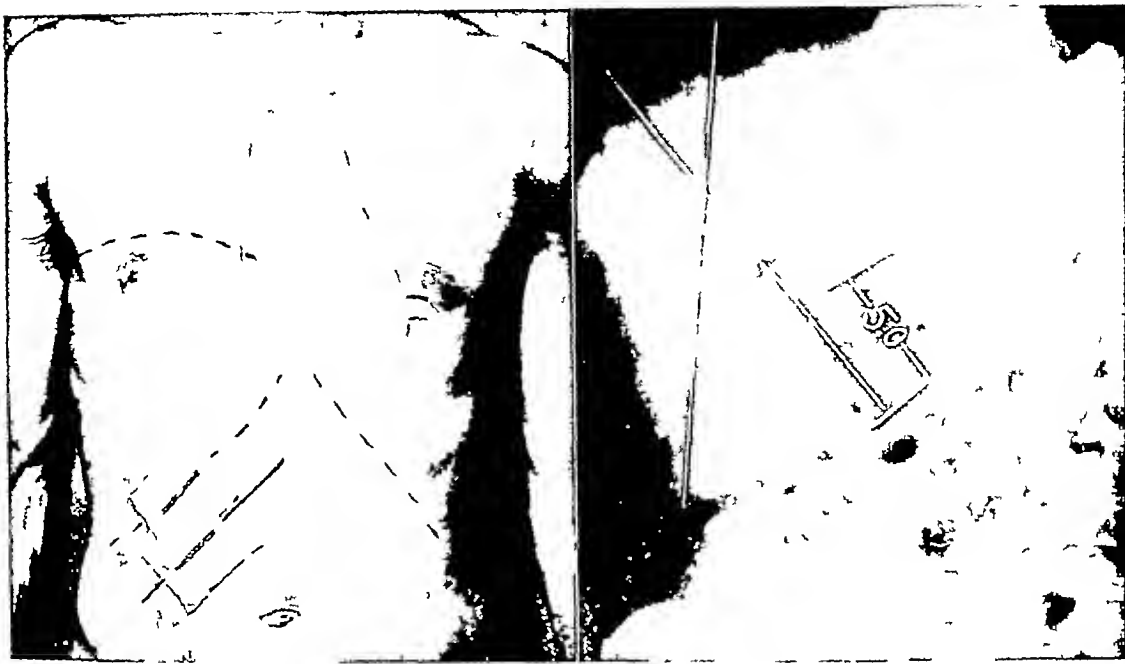


Fig 1 (A) Showing method of placing wire markers on right costal margin in mid-clavicular line and at level below costal margin at which liver edge was palpated at deep inspiration (B) A palpable liver with about average linear measurements, inferior margin lies approximately 5 cm below costal margin at deep inspiration. Close clinical and roentgenological correlation in location of inferior margin (P-A inspiration)

interiliac line Pfahler found the normal length of the right lobe to be from 18 to 22 cm (average 21.3) and the thickness to be from 10 to 14 cm (average 12.8), Moody and Van Nuys found 21.1 the average length. The variations found by the latter workers were somewhat greater and the upper limit of normal was placed at 25.5 centimeters. They made no measurements of the liver thickness.

We studied 53 individuals with palpable livers and a corresponding group of 53 with non-palpable livers. In general, all individuals with palpable livers examined during the period of this study were included. The subjects with non-palpable livers, forming the control group, were taken without selection from those undergoing examination. The palpable group was made up of 47 males and six females, the non-palpable, of 50 males and three females. The subjects of both groups were, in most instances,

without serious complaint. All were very thoroughly examined and in none was a definite clinical diagnosis of liver disease made. In all of the subjects, during quiet breathing, a copper wire marker was fixed by adhesive on the skin at the level of the right costal margin in the mid-clavicular line (Fig 1). When the liver was palpable, a similar marker was placed parallel to the first at the lowest level in the mid-clavicular line at which the liver was felt during deep inspiration. Routinely, in the palpable group, four Bucky films were taken of the entire abdomen and upper pelvis, two with the patient in the postero-anterior and two with the patient in the anteroposterior position. In each of these two positions, one film was made at the end of inspiration and the other at the end of expiration. In each instance an effort was made to center the tube midway between the xiphoid and the umbilicus (or at about the level of the liver



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We did not find this so Meyer-Betz (7) and Glenard and Aimard (4) suggest the injection of air into the stomach and colon or of oxygen into the peritoneal cavity as methods to bring the liver into relief on

and over the liver margin just as in the living subjects, and, in addition, a marker was placed directly on the inferior margin of the liver. The isolated liver was mounted in a cardboard box with the plane of its anterior

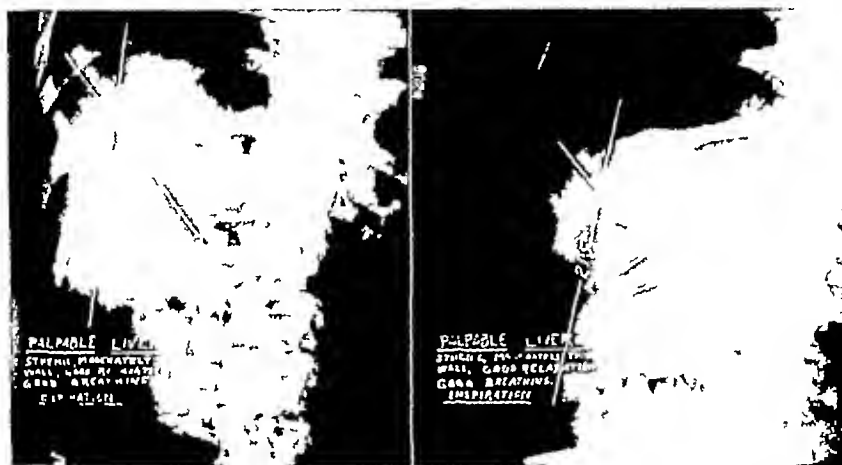


Fig 3 Palpable liver (a) Expiration, (b) Inspiration. Average linear measurements. Inferior margin lies about 5 cm below costal margin at inspiration and is several centimeters below liver margin marker.

roentgenograms. We have not felt it necessary to use either method routinely. The latter authors believe that the liver margin can be better determined by fluoroscopy than by radiography.

After radiographic study of this series had been largely completed, one of us, for a period of several months, investigated the visibility of the inferior margin of the liver routinely on all patients undergoing gastrointestinal examination during both vertical and horizontal fluoroscopy. It was found that the inferior margin often could be visualized rather well during deep breathing, especially with the patient in the horizontal position, and the excursion of the liver was thus noted.

To investigate errors in film measurements due to distortion and exaggeration, roentgenographic studies were made of a cadaver and of an isolated human liver. In the cadaver studies, wire markers were placed on the skin over the costal margin

surface parallel to the bottom of the box. The latter was built up to the thickness of an average abdominal wall. One wire marker was placed directly on the liver edge, and another directly anterior to it on the surface of the artificial abdominal wall. Carefully measured variables in the radiographic technique, such as improper centering of tube, improper position of patient, variable thickness of abdominal wall, and variable target film distance, were introduced (Fig 2). These studies indicated that variations due to such factors as might be introduced during the routine radiographic technique were relatively insignificant for purposes of group comparison.

Table I gives the measurements obtained in our series of cases. Comparison of the average linear measurement on the films taken at inspiration with those taken at expiration shows no great difference, hence we might safely utilize either film as a part of a routine examination for consideration of

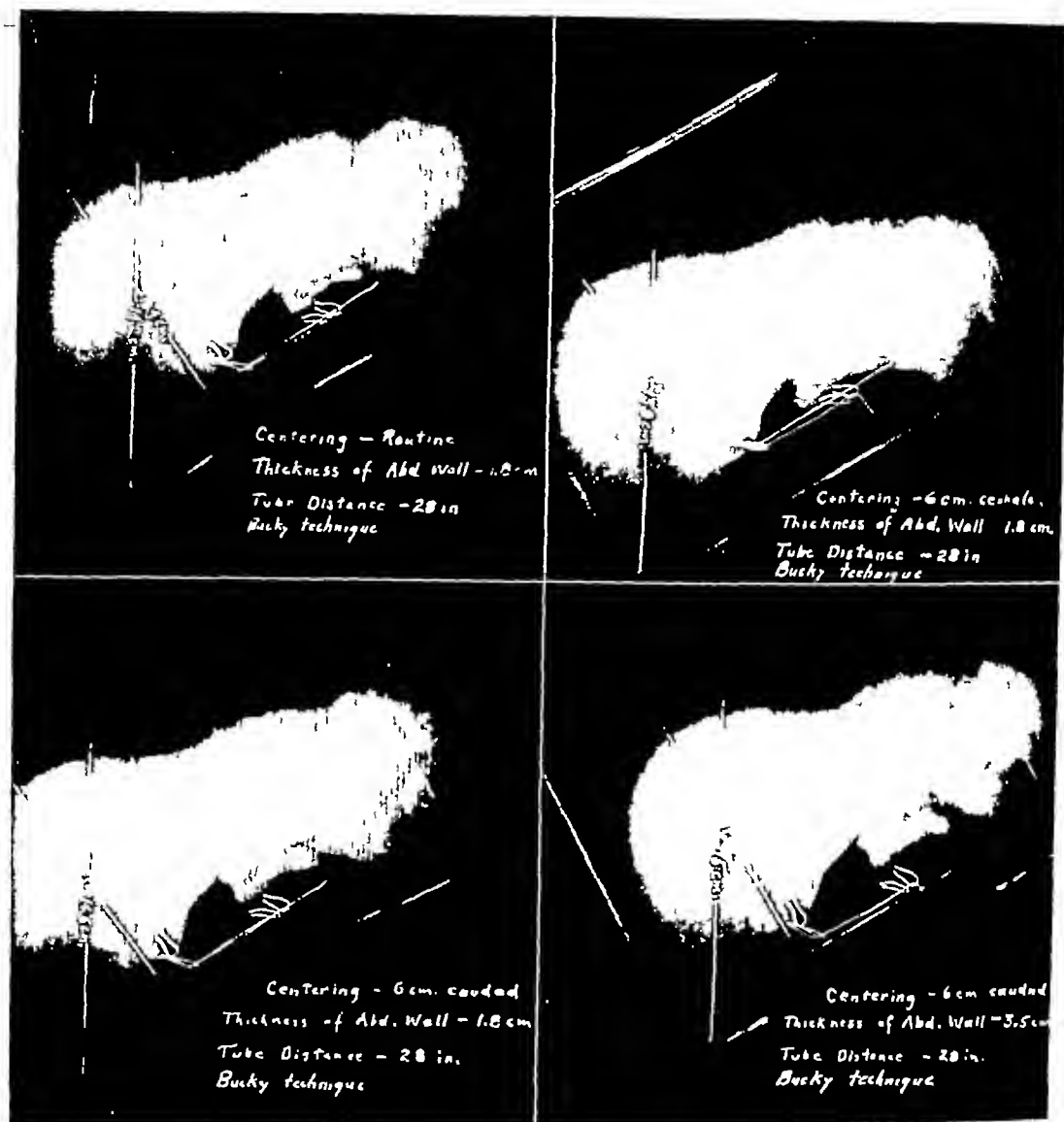


Fig 2 Isolated liver studies to show small variation in measurements caused by improper centering of tube and by variable thickness of abdominal wall (Liver in postero anterior position)

edge) The usual Bucky distance, 28 in., was a constant factor (In the group of non-palpable livers only films at the end of inspiration were taken, since these two films gave the desired relationship of liver edge to costal margin and also afforded over-all measurements of the right lobe) Measurements were made according to the method of Pfahler

We have found that, with the usual Bucky technic, most individuals will show a fairly well defined inferior margin of the right lobe, although, occasionally, the margin cannot be located with sufficient accuracy to make the measurements reliable. Imhorn and Stewart (2) state that denser liver shadows are obtained after administration of dyes for gall-bladder function tests

## LIVER AND GALL-BLADDER FUNCTION

A liver function test with iso-iodelikon was made on 38 patients of the series with palpable livers. In the others, the test was omitted, either because of some possible con-

one-half hour, and 5 per cent or less at one hour, is considered a normal finding. Of the 12 classified as questionably abnormal, 9 showed retention at one hour of from 6 to 10 per cent, of these, five showed reten-



Fig 4 (a) Palpable liver, inferior margin lies about 7 cm below costal margin and about 3 cm below liver margin marker (P-A inspiration)  
(b) Non-palpable liver, linear measurements slightly larger than in (a), inferior margin about 5 cm below costal margin (P-A inspiration)

tra-indication to use of the dye, or poor cooperation on the part of the patient. The dye was prepared and the tests conducted in accordance with the accepted technique. There were no serious reactions. Graham gall-bladder function tests were made in all of our cases in which liver function tests were performed and, using the oral method, in 11 additional subjects in the group with palpable livers, making a total of 49 gall-bladder function studies in the group of 53 palpable livers.

Of the 38 liver function studies, 26 were normal and 12 were regarded as questionably abnormal. A retention in the bloodstream of about 12 per cent of the dye at

tion of from 13 to 25 per cent at one-half hour. Three tests gave normal readings at one hour, but showed retention of from 20 to 40 per cent at a half-hour. None of the one-hour readings is more than 5 per cent increased. In view of the fact that we do not consider this colorimetric method reliable within 5 per cent, we do not consider definitely abnormal any of the 38 cases submitted to the liver function test. Of course, the iso-iodelikon liver function test is by no means an entirely satisfactory method for the positive determination of the presence or absence of liver pathology. The accuracy of this test and other dye tests has been discussed by Waters and King (11), Graham,

TABLE I—LINEAR MEASUREMENTS

*A—Palpable Group*

	Length of right lobe of liver				Thickness of right lobe of liver			
	A-P films		P-A films		A-P films		P-A films	
	Insp	Exp	Insp	Exp	Insp	Exp	Insp	Exp
Average .....	22.9	23.1	20.5	21.9	15.2	15.2	14.1	14.6
Highest figure .....	29.0	29.0	26.6	26.0	20.2	19.2	18.0	17.0
Lowest figure .....	17.0	17.5	14.5	17.5	11.3	11.4	10.5	12.3

*B—Non-palpable Group*

	Length of right lobe of liver		Thickness of right lobe of liver	
	A-P films	P-A films	A-P films	P-A films
	Insp	Insp	Insp	Insp
Average .....	22.3	21.6	14.5	13.9
Highest figure .....	30.2	28.0	18.3	17.5
Lowest figure .....	19.6	17.2	11.7	11.5
Standard deviation .....	2.286	2.19	1.45	1.37
Upper limit of normal .....	31.4	30.4	20.3	19.4
Lower limit of normal .....	13.2	12.8	8.7	8.4

TABLE II

Group	Liver Function				Gall-bladder Function			
	Total No of Tests	Normal	Definitely Abnormal	Questionably Abnormal	Total No of Tests	Normal	No Filling	Poor Concentration or Sluggish Emptying
(A) Non-palpable .....	—	—	—	—	—	—	—	—
(B) Palpable .....	38	26	0	12	49	38	3	8
(1) Definite edge on re-examination .....	10	8	0	2	12	11	0	1

the relative size of the liver. In the non-palpable group, the average length measurement on anteroposterior films taken during deep inspiration (the "Pfahler film" except taken at inspiration instead of expiration) was 22.3 cm, which is 1 cm greater than Pfahler's average, and 1.2 cm greater than Moody and Van Nuys average. The thickness measurement average of 14.5 cm is 1.7 cm greater than Pfahler's average. Surprisingly little difference was found in either the average maximum or minimum measurements of the right lobe on comparison of the 53 palpable livers with the same number of non-palpable ones.

In determining standards of normal size on the basis of the 53 non-palpable liver-

the statistical method was used. The standard deviation<sup>2</sup> was somewhat less in the postero-anterior view than in the anteroposterior. On the postero-anterior projection, it was 2.19 cm for the length measurement and 1.37 cm for the thickness. Considering nothing less than four times the standard deviation to be definitely abnormal, significant enlargement would necessitate a length measurement of 30.4 cm and a thickness measurement of 19.4. On such a basis none of the livers in this series, either palpable or non-palpable, was significantly enlarged (Table I).

<sup>2</sup>The standard deviation was arrived at by taking the individual difference from the average, and

$$\sqrt{\frac{\sum \text{of the squares of the differences}}{\text{number of cases}}}$$

## LIVER AND GALL-BLADDER FUNCTION

A liver function test with iso-iodoikon was made on 38 patients of the series with palpable livers. In the others, the test was omitted, either because of some possible con-

one-half hour, and 5 per cent or less at one hour, is considered a normal finding. Of the 12 classified as questionably abnormal, 9 showed retention at one hour of from 6 to 10 per cent, of these, five showed reten-

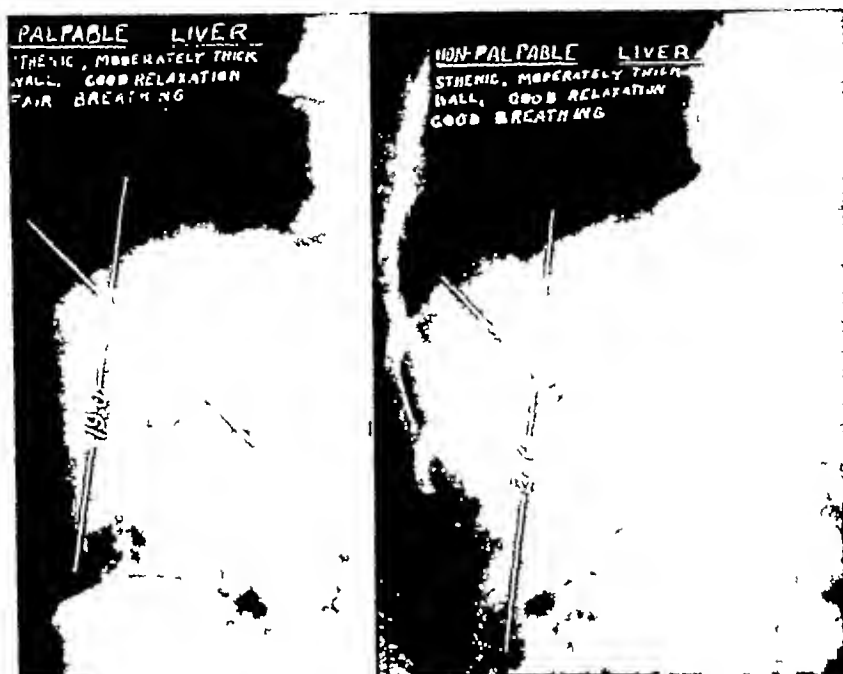


Fig 4 (a) Palpable liver, inferior margin lies about 7 cm below costal margin and about 3 cm below liver margin marker (P-A inspiration) (b) Non-palpable liver, linear measurements slightly larger than in (a), inferior margin about 5 cm below costal margin (P-A inspiration)

tra-indication to use of the dye, or poor cooperation on the part of the patient. The dye was prepared and the tests conducted in accordance with the accepted technic. There were no serious reactions. Graham gall-bladder function tests were made in all of our cases in which liver function tests were performed and, using the oral method, in 11 additional subjects in the group with palpable livers, making a total of 49 gall-bladder function studies in the group of 53 palpable livers.

Of the 38 liver function studies, 26 were normal and 12 were regarded as questionably abnormal. A retention in the bloodstream of about 12 per cent of the dye at

tion of from 13 to 25 per cent at one-half hour. Three tests gave normal readings at one hour, but showed retention of from 20 to 40 per cent at a half-hour. None of the one-hour readings is more than 5 per cent increased. In view of the fact that we do not consider this colorimetric method reliable within 5 per cent, we do not consider definitely abnormal any of the 38 cases submitted to the liver function test. Of course, the iso-iodoikon liver function test is by no means an entirely satisfactory method for the positive determination of the presence or absence of liver pathology. The accuracy of this test and other dye tests has been discussed by Waters and King (11), Graham,

TABLE III—FACTORS POSSIBLY INFLUENCING PALPABILITY

Group		No of Cases	Build							
			Hypersthenic		Sthenic		Hyposthenic		Asthenic	
			No	%	No	%	No	%	No	%
(A)	Non-palpable	53	3	6	34	65	3	6	12	23
(B)	Palpable	53	9	18	29	56	8	16	5	10
(1) Definite edge on re-examination		12	1	8	9	76	0	0	2	16

Thickness Abdominal Wall						Relaxation Abdominal Wall					
Thick		Medium		Thin		Good		Fair		Poor	
No	%	No	%	No	%	No	%	No	%	No	%
7	22	13	42	11	36	10	50	7	35	3	15
6	21	21	72	2	7	21	72	7	25	1	3
1	8	10	84	1	8	12	100	0	0	0	0

Breathing						Average discrepancy between liver margin marker and liver margin	
Good		Fair		Poor			
No	%	No	%	No	%		
2	40	3	60	0	0		
13	48	12	44	2	8	2.2 cm	
7	58	4	33	1	9	2.4 cm	

TABLE IV

Group		No of Cases	Average Length		Average Thickness	Average Distance Liver Margin below Costal Margin (cm)
			P-A	Inspiration	Film	
(A)	Non-palpable	53	21.6		13.9	3.5
(B)	Palpable	53	20.5		14.1	4.5
	(1) Definite edge on re-examination	12	20.6		13.9	4.1

Cole, Copher, and Moore (5), Barker (1), Greene, Snell, and Walters (6), and others. We may conclude that, insofar as the test with iso-iodoikon is an accurate index of liver function, the large majority of palpable livers in our group do not have abnormal function.

Of the 49 gall-bladder function tests (38 intravenous and 11 oral) only three showed complete non-filling, eight showed poor concentration or sluggish emptying; the remaining 38 (77 per cent) showed entirely normal Graham reactions. Of the 11 cases in which the Graham reaction was not entirely normal, the liver function was normal in four, questionably abnormal in four and not tested in three. In view of the large percentage of strictly normal Graham function tests in our group of palpable livers

we may conclude that there is no close correlation between palpability of the liver and gall-bladder function (Table II).

#### OTHER FACTORS POSSIBLY INFLUENCING PALPABILITY

Failure to find any significant difference in size between the palpable and non-palpable livers, and the absence of definite evidence of diminished liver or gall-bladder function in the great majority of the palpable livers, led to a consideration of other factors possibly influencing palpability. Body build, body weight, thickness and relaxation of the abdominal wall, depth of respiratory movements, and distance of the liver edge below the costal margin were given consideration (Table III).

FACTORS POSSIBLY INFLUENCING  
PALPABILITY

The judgment of the examiner in determining which livers were palpable was considered a possible source of error. At the

were compiled separately for the 12 cases in which a definite liver edge was felt (Table IV)

No certain correlation was found between body build and palpability of the liver,

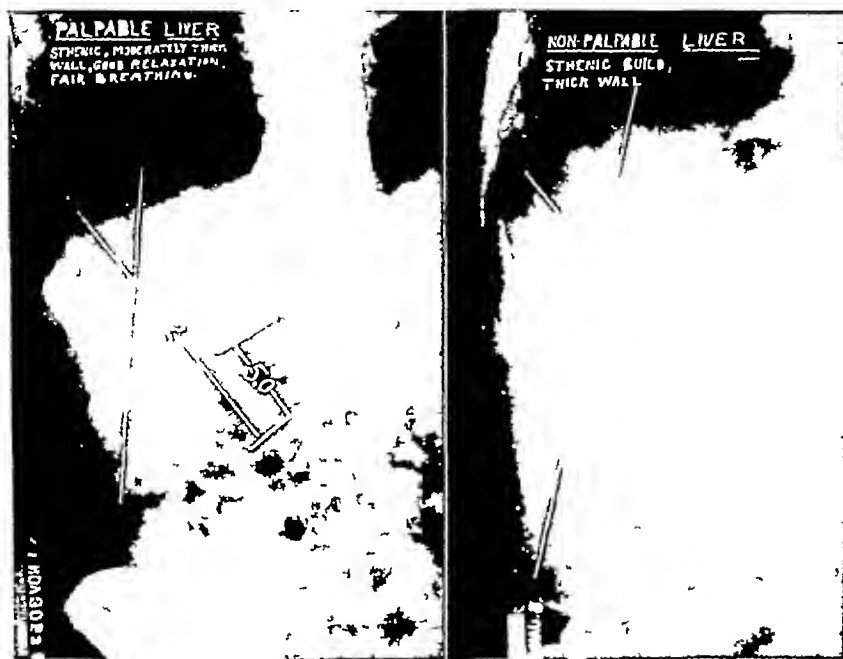


Fig 5 (a) Palpable liver, inferior margin 5 cm below costal margin close agreement of clinical and roentgenologic localization of inferior margin (P-A inspiration) (b) Non-palpable liver, measurements well above average, but liver not significantly enlarged. Liver margin about 4 cm below costal margin in mid-clavicular line (P-A inspiration)

time of the original studies, 19 of the 53 cases classed as having palpable livers were seen by at least two examiners. Twenty-seven of the original palpable group were recalled and each was examined by three physicians. In nine cases there was unanimous agreement that a definite sharply defined liver edge could be felt. In three cases, two of the examiners felt a definite edge, but a third did not feel it. In the remaining 15 cases, a definite edge could not be felt. In certain instances there was a sense of resistance, suggestive of liver, in others (even some in which the liver originally had been considered by two examiners to be palpable) nothing could be felt. Data

however, the original palpable group contained more hypersthenic and fewer asthenic individuals than the non-palpable group. We believe that a hypersthenic build may be more favorable to palpation, due to the fact that the inferior margin of the descending liver lies more transversely and, therefore, is more nearly perpendicular to the line of movement. In consequence, with respiration it meets the palpating hand squarely instead of obliquely.

No correlation was shown between body weight and palpability of the liver.

Thickness of the abdominal wall did not appear important in affecting palpability, there being about the same percentage of



thick-walled individuals in the palpable and non-palpable groups, with a larger percentage of thin-walled individuals in the non-palpable group

A considerably higher percentage of in-

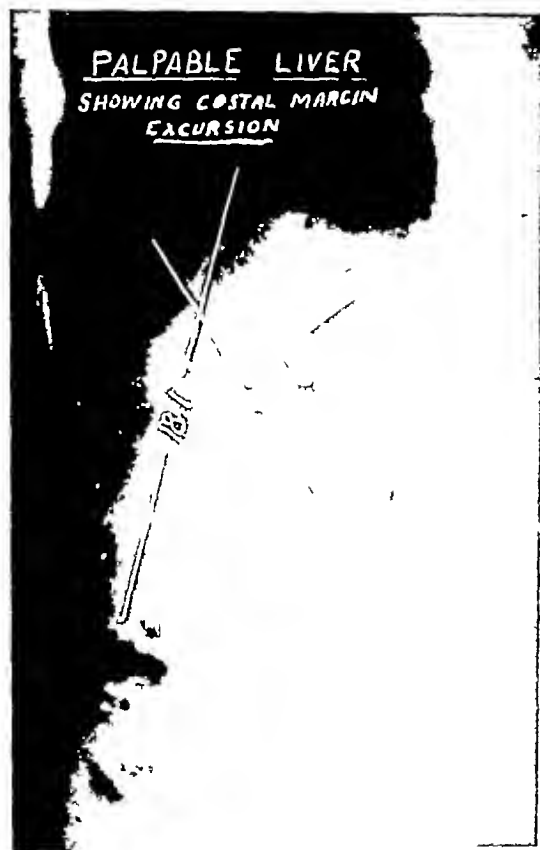


Fig 6 Palpable liver with markers at liver margin. Costal margin quiet breathing and (highest marker) costal margin, deep inspiration. Average discrepancy at deep inspiration between upward movement of costal margin and that of costal margin marker placed during quiet breathing two centimeters

dividuals in the palpable group was classed as having good relaxation of the wall. Since a liver cannot, of course, be felt through an absolutely rigid abdominal wall, relaxation must, at times, be a factor, although it has not seemed an important one in this series.

While, on most of our films taken at expiration, the inferior border of the liver was found to be near the costal margin in nearly all instances on satisfactory inspiration the liver edge moved downward well below the

costal margin. The fluoroscopic observations, previously referred to, also showed in inspiration a descent of the liver border below the costal margin in almost every instance, usually for at least 3 cm in the mid-clavicular line. Unsatisfactory breathing by the individual at the time of radiographic study undoubtedly was responsible for some of the greatest discrepancies between the radiographic and palpatory locations of the liver margin. Little correlation was found between palpability and the distance of the liver edge below the costal margin as determined by roentgenography. In the palpable group, the liver edge averaged only one centimeter lower than in the non-palpable group. In numerous cases in which the liver was not felt, the border lay quite definitely from 4 to 6 cm below the costal margin, where it certainly should have been palpable, if location were the major factor. In a recent investigation of liver size in relation to gall-bladder disease, Feldman (3) reported 95 of 97 livers to lie above the costal margin, but he did not state clearly the position of the patient or the phase of respiration at which his observations were made. Toward the end of this study, it was realized that the wire marker placed over the costal margin during quiet respiration did not mark the position of the costal margin with the breath held at deep inspiration. The costal margin was found to move upward more than the marker so that, at the end of inspiration, there was an average distance of two centimeters between them. This means that, in both the palpable and non-palpable groups, the liver margin during deep inspiration was actually about two centimeters farther below the costal margin in each case than our measurements indicate (Figs 3 + 5 and 6).

#### COMMENT

That linear measurements of the right lobe of the liver give only a rough approxi-

mation of actual liver size seems obvious when one considers the well known variations in normal shape in different individuals. We do not feel that linear measurements are a very accurate index of size in

history and careful physical examination revealed clinical evidence suggestive of liver disease in but two of the subjects, and few of the subjects gave even slightly abnormal function tests

COMPARISON OF LINEAR MEASUREMENTS AND RELATION OF INFERIOR  
MARGIN TO COSTAL MARGIN  
ON INSPIRATION

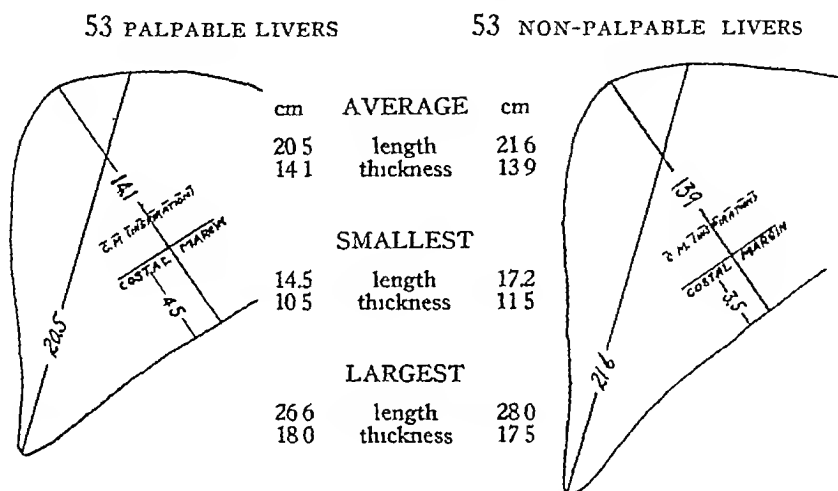


Fig 7 Diagrammatic outlines of right lobe of liver in palpable and non-palpable groups. Over-all measurements of right lobe and relation inferior margin to costal margin not significantly different in the two groups

any given case, but we do believe that there is something of value in the comparison of averages of large groups of cases. The absence of any appreciable difference between the palpable and non-palpable groups is rather striking (Fig 7). After giving full consideration to all factors possibly influencing palpability, we have been forced to conclude that neither body build and weight, thickness and degree of relaxation of the abdominal wall, the depth of respiratory movements, the size of the liver, nor the distance that the liver projects below the costal margin have been found to be of great importance in determining palpability.

Firmness of the liver substance is a factor, probably of great importance, but which does not lend itself to direct observation, except at postmortem examination. Increased firmness might supposedly be due to fibrosis and to indicate disease. Detailed

The findings in the cases re-examined, which showed unquestionably palpable livers, corresponded to those in the entire group originally classed as palpable. Another series of subjects with palpable livers is being accumulated and care is being taken to include no questionable cases, in an attempt to throw further light on the problem.<sup>3</sup>

#### CONCLUSIONS

Body build and weight, thickness and relaxation of the abdominal wall and depth of the respiratory movements were not demonstrated to be of major importance in explaining palpability of the liver, in our series.

As a rule, the inferior margin of the liver

<sup>3</sup>The authors wish to express their sincere appreciation to Dr. T. I. Squier for constructive criticism throughout the course of the study, Dr. Roy Benton for clinical assistance, Burr Anderson and Lyle Tyrrell for the illustrations, and Mrs. Evelyn Jensen for assistance in preparation of the manuscript.

lies at least several centimeters below the costal margin at deep inspiration, with the individual in the horizontal position

Palpability of the liver rarely was associated with clinical evidence of disease or diminished dye excretion

Palpable livers are not necessarily large livers. In our group their linear measurements were no greater than in an unselected control group of non-palpable livers

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### OBSERVATION IN A PRELIMINARY STUDY OF TUMOR HISTOLOGY AND BONE METASTASES<sup>1</sup>

By ELWOOD E. DOWNS, M.D., and WILLARD S. HASTINGS, M.D., PHILADELPHIA  
From the Departments of Roentgenology and Pathology of the Jeanes Hospital

**B**ONE metastases were recognized as early as 1834, by Sanson. In 1891, von Recklinghausen described two types: one, diffuse and destructive, which he termed osteomalacia carcinomatosa, and a second type, osteoplastic in character. Numerous cases have been reported, theories have been advanced as to the avenues of dissemination, and reasons have been suggested for the variations in these metastases.

Assmann believes that the presence of necrotic bone stimulates the production of new bone. Several observers have stated that hyperplastic lesions occur late and that they are secondary to an osteolytic process. Prahler suggests that the sclerosis is prob-

ably an indication of Nature's attempt to isolate the disease, and that it is more frequently found in cases that develop slowly. Handley believes that the hyperplastic lesions are found in those cases in which there has been a non-infective inflammatory reaction in the bone, as a result of the tumor invasion. We will make no attempt at this time to discuss these and other theories, most of which we accept as logical deductions.

Leddy, in his paper on bone metastases including 40 cases, says: "There is, superficially, no relationship between the histologic character of the tumor and the incidence or type of metastasis."

Ewing has called our attention to the radioresistance of tumors which exhibit

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

TABLE I

Case Number	Age First Symptom	Age on Admission	Interval between Appearance and Death	Interval between Appearance and Bone Metastases*	Local Recurrence
555	37	40	4 years	2 years, 6 months	Yes
1324	56	56	4 months	1 month	No operation
104	43	44	1 year	9 months	Yes
1182	62	69	7 years, 6 months	7 years	No operation
1002	68	69	2 years	1 year, 6 months	No operation
489	57	59	3 years	2 years, 6 months	No
1273	47	50	3 years, 9 months	3 years, 6 months	No
1022	43	44	8 months	2 months	No operation
732	66	68	3 years	2 years	
782	60	63	3 years	10 months	Yes
586	42	44	2 years, 8 months	3 years	No operation
1223	44	44	5 months	2 years, 7 months	No
821	68	69	1 year, 3 months	5 months	No operation
450	81	81	1 year, 9 months	1 year	No operation
1025	60	62	2 years, 6 months	1 year 3 months	Yes
1214	55	58	3 years (alive)	2 years, 6 months	Yes
435	60	61	1 year, 9 months (alive)	1 year, 6 months	No
540	32	38	7 years	6 years	Yes
1401	65	68	6 years (alive)	2 years, 8 months	No
175	79	80	9 years	9 months	No operation
Average	56.5	58.5	2 years, 6 months	2 years, 3 months	54 per cent of operable cases
Greatest Deviations from Average	81 32	81 38	7 years, 6 months 4 months	6 years 1 month	

\*This interval refers to the discovery of metastases which in some instances were already present when the case was first seen

TABLE II

Case Number	Tumor	Primary Location	Degree of Desmoplasia	Types of Metastases
104	Carcinoma simplex	Breast	DD	Sclerosing
175	Carcinoma simplex	Prostate	D	Destructive
435	Carcinoma simplex	Breast	D	Destructive and sclerosing
584	Squamous-cell carcinoma	Vagina	D	Destructive
450	Carcinoma	Prostate	DD	Sclerosing
540	Adenocarcinoma	Breast	O	Destructive
555	Carcinoma simplex	Breast	DD	Destructive and sclerosing
486	Epidermoid carcinoma	Cervix	O	Destructive
732	Hypernephroma	Adrenal	O	Destructive
782	Sarcoma (spindle)	Flank	D	Destructive
821	Fibrosarcoma	Bladder	DDD	Sclerosing
1002	Carcinoma simplex	Breast	D	Destructive and sclerosing
1022	Adenocarcinoma	Kidney	DD	Destructive and slightly sclerosing
1025	Carcinoma simplex	Breast	DD	Destructive and slightly sclerosing
1182	Carcinoma simplex	Breast	D	Destructive
1214	Alveolar carcinoma	Breast	DDD	Sclerosing
1223	Medullary carcinoma	Breast	O	Destructive
1273	Carcinoma simplex	Breast	D	Destructive
1324	Carcinoma simplex		DD	Destructive and slightly sclerosing
1401	Scirrhus carcinoma	Breast	DDD	Destructive and slightly sclerosing

marked desmoplasia. In an effort, therefore, to estimate the radiosensitivity of our tumor cases, we have adopted the practice of carefully noting and reporting, in the histologic examination, the amount of desmoplasia.

There are at least two factors to be considered in the production of desmoplasia: one, which is a characteristic of the tumor cells of the individual case, and a second, which is a process of repair following necrosis. The former of these is the factor

which we feel is of more importance in this study

The small group of cases, 20 in number, is not sufficient to establish any facts concerning bone metastases, but it does suggest to us another theory. If the primary tumor has the property of exciting a marked desmoplastic reaction in its growth, then this same property will manifest itself when bone metastases appear, and will stimulate a sclerosing type of lesion, also that the anaplastic, highly cellular tumors produce osteolytic changes in their bone metastases. There are, to be sure various gradations of desmoplasia and anaplasia and the large percentage of primary neoplasms are both anaplastic and desmoplastic. Accordingly, in the majority of cases, both destructive and sclerosing lesions are prominent.

It would seem rational to believe that, if the primary tumor cells have the power to excite the growth of fibroblasts and young connective tissue, these identical cells when lodged in the bones, would likewise stimulate the formation of osteoblasts, which are so closely akin to the fibroblasts. We do not believe with Kaufmann and others that epithelial cells can possibly become osteoblasts.

There are certainly numerous other factors concerned in the development of osteolytic and osteogenic metastatic lesions. The age of the patient pre-existing constitutional diseases and endocrine disturbances undoubtedly have their influences. Along

this line, we propose to make a study of the calcium metabolism in these cases in an attempt to determine what role, if any is played by the parathyroids.

#### CONCLUSIONS

The 20 unselected cases, all of which are included in our exhibit, suggest to us a theory of a relationship between the histology of the primary tumor and the character of its bone metastases. There are undoubtedly several other significant factors concerned in the genesis of bone metastases which help to explain the exceptions which we find to our theory.

#### DISCUSSION

DR. DOWNS (closing remarks) The one point I might add is that I hope other members, when they have the opportunity of seeing the histologic structures of the tumors will attempt to correlate them with the roentgenograms.

There are numerous other factors as we mentioned in our paper, which exert their influence on the type of metastases. We would not expect to find a sclerosed lesion in a person who already was old and had a generalized osteoporosis, nor would we expect it in a general carcinomatosis of the bone. Our bones, in themselves, are the storehouse of calcium, and, if all the available calcium has been used, the sclerosing lesion cannot be produced.

We have become very much interested in the work and I hope it will stimulate others to continue with the study.

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# BRONCHOGRAPHY AN AID TO THE ROENTGENOLOGIST<sup>1</sup>

By LEWIS G ALLEN, M.D., KANSAS CITY, KANSAS

ANY procedure which renders visible the invisible, is hailed with acclaim, as well as a vote of thanks from those whose work includes the attempt to evaluate the invisible. In the experience of all of us who study the intestinal tract by means of the roentgen ray, are instances in which the opaque medium has been observed to enter the tracheobronchial tract. In such cases we have been impressed with the absence of pulmonary reaction. The suggestion, then, of the intentional introduction of some contrast medium into the respiratory tract has been received with a genuine feeling of confidence by roentgenologists.

The method of introduction of iodized or bromized oil has been the subject of a rather voluminous literature. Each modification has its enthusiasts, depending first on the primary interest of the introducer, whether he be a bronchoscopist, pediatrician, internist or other specialist, and secondarily the age of the patient for whom the procedure is contemplated. In general, the methods employed in the introduction of the oil into the bronchi fall under the following heads:

- 1 Through a bronchoscope, directly into the bronchus desired
- 2 The intercricothyroid route, by which the oil is introduced into the trachea by an intercricothyroid puncture, through a trocar cannula resembling a tracheotomy tube first used by Sicard and Forestier (1) and Armand-Delille (2)
- 3 Into the trachea through a tracheal or modified catheter under direct illumination with or without the employment of a laryngoscope
- 4 Through an intubation tube, as suggested by Iglauer (3)

5 The "passive method" of Ochsner and Nesbit (23), by which, after anesthetizing the pharyngeal structures, the act of swallowing permits the oil to enter the trachea

6 Instillation of the oil directly into the trachea with or without anesthesia of the pharynx, as suggested by Singer (4)

The last-named method is the least complicated, furthermore, it fills the requirements of the busy roentgenologist and is applicable in more than 80 per cent of cases. Preliminary anesthesia of the pharynx by spray of cocaine solution is required in only those cases possessing intolerant throats. A tracheal cannula cut to about two-thirds length, having a short bend at approximately 105° at the tip and fitted to a 20 c.c. syringe, is all the apparatus required (Fig. 2).

The patient is seated, inclining to the side to which the physician desires the oil to gravitate, the tongue is grasped with the aid of a gauze sponge, pulled forward to the limit of comfort, and the oil dropped into the trachea during inspiration. The exact position the cannula tip should occupy is that in which single drops of the oil seem to be deflected exactly upward by the current of air of expiration coming from the trachea. A beam of reflected or direct light will assist in locating this exact point. The entire procedure consumes only slightly more time than the average fluoroscopic examination, and, if desired, the degree of filling can be observed fluoroscopically.

The field of application of bronchography is potentially narrow, being limited to those lesions not otherwise radiographically apparent and specifically that group in which the visualization of the bronchi may add amplification. These lesions obviously comprise those which affect the lumen of the

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

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this line, we propose to make a study of the calcium metabolism in these cases, in an attempt to determine what role, if any, is played by the parathyroids.

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the congenital and acquired types. A review of the literature and our own experience has led to the following classifications as to etiology

# 1 CONGENITAL

- (a) Arrest in development
- (b) Accumulation of fluid
- (c) Adenoma
- (d) Pressure
- (e) Congenital syphilis
- (f) Valvular bronchial stenosis

# 2 ACQUIRED

## (a) Non-infectious

- 1 Foreign body
- 2 Tumor (aneurysm)
- 3 Cicatricial stenosis (scar tissue)
- 4 Plugging of bronchus from rare causes

## (b) Infectious

- 1 Co-existent with paranasal sinusitis
- 2 General bronchioectasis in young children following acute bronchitis
- 3 Bronchial dilatation co-existent with atelectasis
- 4 Following fibroid pulmonary tuberculosis
- 5 Following pneumonia and lung abscess
- 6 Following empyema
- 7 Following acute or chronic bronchitis
- 8 Following measles, influenza, or pertussis

Regarding the bacteriology of bronchiectasis, L. H. Ermatinger (7) reports, from a series of 33 cases of bronchiectasis at Barnes Hospital, the following organisms, and percentage of incidence

- 1 *Micrococcus catarrhalis* (90 per cent)
- 2 *Staphylococcus aureus* (60 per cent)
- 3 *Hemolytic streptococcus* (40 per cent)
- 4 *B. Mucosus-capsulatus* (40 per cent)
- 5 *Pneumococcus* (40 per cent)
- 6 *Bacillus xerosis* (30 per cent)
- 7 *Fusiform bacillus* (10 per cent)

He considered the predisposing factors to be foreign body (broncholithiasis) influ-

enza, pneumonia, measles, bronchitis, pertussis, and tonsillectomy

One regards the congenital type of bronchiectasis as the only dilatation that is congenital. The nature and course of the process of dilatation is rather indefinite, though several suggestions in explanation have been offered, for instance, the theory of arrest in development as advanced by Kaufmann (8) and supported by Pepere and Dionisi, and the suggestion of Grawitz (9) that an accumulation of fluid in the fetal bronchioles is the cause of dilatation in many cases. Congenital fetal adenoma was considered the etiological factor in many cases reported by Stoerk (10). Sauerbruch (11, 20) suggests that the crowding of the left main bronchus during early development by Cuvier's duct should not be overlooked, and Blazer and Grandhomme (12), with others, claim that congenital syphilis plays an important rôle.

Bronchiectasis when acquired and of a non-infectious origin may be due to a partial or complete blocking of the bronchus from such agents as a foreign body, a tumor, *et cetera*. One of the earliest workers on this subject, Reynaud (13), observed that the dilatation usually occurred both distal and proximal to the point of obstruction as well as in the nearby unobstructed branches. All seem to agree that although non-infectious in origin, infection soon becomes a complicating factor.

Corrigan (14) observed the relationship between fibrosis of the lung and bronchiectasis in that the scar tissue retraction in the lung was the source of extra-bronchial traction resulting in dilatation. In cases of bronchiectasis associated with chronic fibroid phthisis, the dilatation can be accounted for by the scar tissue retraction of the bronchial walls. The same may be applied to chronic empyema. In any condition in which an inflammatory process has weakened the bronchial wall it must be considered as most



bronchus by obstruction, stenosis, dilatation, position, course, and relationship

The chief indications for bronchography may be classified as follows

- 1 Bronchiectasis, and the study of the post-cardiac space
- 2 The differentiation of lesions of the pleural cavity from those of the lung parenchyma
- 3 The effect of therapeutic efforts, particularly multiple stage operations, and the evaluation of residual pathology
- 4 The localization of the trachea and bronchi as an aid in differentiation of lesions of the mediastinum and pericardium

It is well to recall that the bronchial tree, in addition to its classical function, acts as a support to the parenchymal structures. The terminal bronchi, in contrast to the primary branches, contain no cartilaginous rings, and, therefore, receive rather than transmit support. Ballon and Ballon (5) have shown that the position of the larger bronchi are fairly constant in man and quote Ewart as having proved by calculation that the lungs of infants contain the same elements as those of the adult, their size only being different, consequently, the normal bronchial tree as visualized by the bronchograph at various age periods is constant. "The size of the products of a bifurcation of a bronchus is equal to that of the parent," quoting the same author, and, of two diverging bronchi, the smaller diverges most from the position of the parent tube. The bifurcation

of the trachea shows a variation as to the exact site in the normal subject, the left bronchus is more oblique and is smaller than the right, which is shorter and wider, passing down as a direct continuation of the trachea.

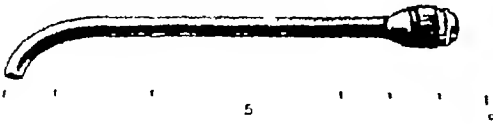


Fig 1 An ordinary silver intratracheal cannula cut to about 9 cm length, including a short bend at the tip of approximately 115 degrees, fitted to a 20 c.c. Luer type syringe, has proven most satisfactory for an intratracheal instillation of the oil

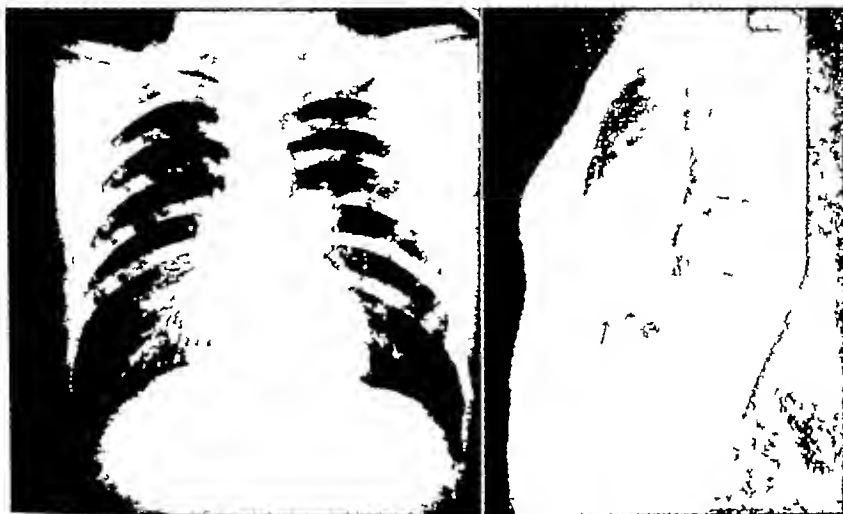


Fig 2 The patient is seated in an upright position, inclined to the right or left as desired. The tip of the tongue is grasped with a gauze sponge and pulled forward to the limit of comfort. The lower position of the tongue permits the saliva to flow out of the mouth. The position of the tip of the cannula is determined by the character of the deflection of a drop at the cannula tip and injection is made directly into the trachea during inspiration.

Bronchiectasis, the most frequent indication for bronchography, is defined as a dilatation and an inflammatory process in the wall of a bronchus or the entire bronchial tree. It has been the subject of intensive study by many workers since the advent of the application of bronchography. Hartung (6) showed in an analysis of 92 cases that the diagnosis of bronchiectasis could be made in only 60 per cent from the plain films, and it has been proven repeatedly that the signs of bronchiectasis upon which we have previously depended, are present in only late stages of the affection. Much has been written regarding the etiology of both

associated with enlargement of the members of the bronchial tree. There is a cylindrical enlargement, with little or no inflammation of the bronchi. It is ordinarily discovered accidentally, rather than because of symptoms, and as a rule is limited to one lobe,

cur in combination. The alveoli between are crushed and collapsed and undergo permanent cicatricial atrophy. From mutual pressure, the walls of touching ectatic secondary bronchi may disappear, and several form a communal sac analogous to anasto-



Figs 4-A and 4-B Localized bronchiectasis secondary to bronchial stenosis. Note the fine adhesion of the diaphragm in the lateral projection indicated by arrow, and the failure of visualization by the oil at this segment of the lower lobe. Confirmed by bronchoscopic examination.

although it may be more widespread. In the second form, such as that described by Koeckert, the alveoli show complete failure of development and the bronchus grows out from the primary tube as an extremely thin-walled, cyst-like mass replacing an entire lobe or an entire lung. It is, therefore, a balloon-like distention of an improperly developed large bronchus. It is lined by cylindrical epithelium and in its wall shows isolated areas of cartilage and of muscle. If extensive, the condition is not consistent with life.

According to the form, pathologists speak of cylindrical or diffuse, and sacculated or circumscribed bronchiectasis, with the spindle-shaped form between. When several saccular dilatations follow one another, the condition is referred to as "varicose bronchiectasis," and several forms may oc-

curring varices. In rare cases an extensive cavity takes the place of a large area of the lung.

Diffuse bronchiectasis often presents uniform dilatation extending to the pleura, while frequently the extreme distal ramifications are most markedly dilated. The diffuse type of lesions are found most frequently in the lower lobes. When the lesion is of the saccular or spindle-shaped type, efferent small branches, as well as the central area, are frequently seen, and may also reach the periphery. Purely saccular dilatations are found most frequently in the upper lobes. The walls of the bronchiectatic bronchus may be either atrophic (if the wall is thinned to a transparent serosa-like membrane) or hypertrophic in which case the wall is changed as in chronic catarrh, often polypoid moist and vascular. The latter

important as an exciting cause. The same is particularly logical in cases in which the dilatation is localized.

Rist (15), a French surgeon, was the first to observe and call attention to the association of bronchiectasis and upper respiratory

Bronchitis, 16 per cent

Pneumonia, 16 per cent

Infectious disease of children, 13.6 per cent

Foreign bodies in the bronchus, 5.2 per cent

Post-operative pulmonary infection, 4.7 per cent



Fig. 3. Bronchograms of right lower lobe, same patient at a thirty-day interval, demonstrating consistency of a bronchograph obtained after the instillation of iodized oil by the method of Singer.

infections, and Webb and Gilbert (16), in 1921, were the first in this country to advocate roentgen examination of the sinuses in such cases. From a series of their cases they found the pus from washing contained the same organisms as the sputum, usually *Pneumococci*.

The experimental work of Mullin (17) has shown the two routes which connect the accessory sinuses to the lungs and bronchi to be, first, the lymphatic circulatory route and second, the inhalation or bronchial route. The former can function even in the case of an antrum which does not discharge at all into the nose, and the latter is open to any substance reaching the nasal fossæ, provided it be converted into droplets or aspirated by inspiration.

In a series of 552 cases of bronchiectasis, reported by Hedblom (18), the causes given are as follows:

The greater percentage, therefore, must come from some remote cause. Quinn and Myer (19) report a series of 38 cases of bronchiectasis in which 20 (or 57.9 per cent) had a co-existent sinusitis. Dennis reported that in 52 patients with bronchiectasis, 47 had involvement of the maxillary sinus. Lockwood's analysis of the incidence of pulmonary fibrosis, with nasal sinus disease, points to a rational mechanism. The types of sinusitis regarded as of etiologic significance are, in the order of their frequency, pan-sinusitis, bilateral maxillary sinusitis, and ethmoiditis. As though to prove the rule, a series reported by Quinn and Myer, the majority did not have—or give—a history of sinusitis.

Regarding detail pathology, the congenital types of bronchiectasis are of two main varieties. In one form there is usually failure of development of the alveolar sacs

associated with enlargement of the members of the bronchial tree. There is a cylindrical enlargement, with little or no inflammation of the bronchi. It is ordinarily discovered accidentally, rather than because of symptoms, and as a rule is limited to one lobe,

cur in combination. The alveoli between are crushed and collapsed and undergo permanent cicatricial atrophy. From mutual pressure, the walls of touching ectatic secondary bronchi may disappear, and several form a communal sac analogous to anasto-



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curring varices. In rare cases an extensive cavity takes the place of a large area of the lung.

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condition offering an explanation of bronchial hemorrhage in bronchiectasis. The wall is surrounded by abundant fibrous tissue and trabecular hypertrophy, which accounts for the honeycomb appearance seen in advanced cases. The contents varies

The abnormal position and the relationship of the bronchi after the differential criteria.

The bronchograph is the means of accurate evaluation of therapeutic results, by both operative and non-operative measures including the multiple stage operation, par-



Fig 5 (left) Bronchograph of the left lower lobe showing cylindric bronchiectasis. The oil in the right lower lobe remains from a previous instillation. Cf Fig 6.

Fig 6 (right) The oil is shifted to the right upper lobe by turning the patient on the right side in a semi-inverted position. Cf Fig 5.

from air to thick, slimy secretion or grumous, cheesy material, the latter occasionally calcified.

The Ballons' (5) classification of bronchiectasis, based on the injection of iodized oil, includes five types, viz, cylindrical, grape, bead, clubbed, and saccular. They consider these types as denoting the age of the disease as well as describing the condition of the bronchus and distal lung parenchyma. Any classification is destined to prove inadequate, due to overlapping of types.

The value of bronchography in the differentiation of lesions of the pleural cavity from those of the lung parenchyma include infiltrations at either site, particularly pneumonitis, massive pleural thickening, infiltrative tumors, encysted hydrothoraces, etc.

tial or complete thoracoplasty, pneumothorax, postural or localized drainage, as well as other measures. Radiologists depend on the importance of the position of the trachea as a differential guide in cases of extensive pulmonary pathology. When such is invisible as a result of extensive mediastinal infiltration or neoplasm, cardio-aortic or pericardial pathology, the handicap may be overcome by bronchography.

The contra-indications for the employment of the method are, grossly, those which alone deny the mechanical manipulation of the procedure, such as advanced cardiac disease with respiratory embarrassment and the presence of acute or recent upper respiratory infections. Advanced pulmonary tuberculosis—certainly in those cases accompanied by marked elevation of

temperature or recent hemoptysis—constitutes a contra-indication, recalling, however, that hemoptysis frequently accompanies bronchiectasis

Pritchard, Whyte, and Gordon (22) report six cases of mild iodism in the form of

ties should not be employed for this reason if for no other Archibald and Brown (24) point out the danger of the plugging action of the oil as it floats above the purulent secretion and theoretically causes the longer retention of infected material, and that the



Fig 7 (left) Localized bronchiectasis (indicated by arrow) following a lung abscess which was treated by pneumothorax

Fig 8 (right) Pulmonary fibrosis secondary to resolving lobar pneumonia, illustrating altered bronchial radiation

an irritable rash in a series of 1,000 cases Archibald (21) cites Forestier as having shown the elimination of 0.02 gm iodide in the first 24 hours following the administration of 20 c c of lipiodol Brauer adds three cases of iodism after lipiodol Therefore, cases of hyperthyroidism, and particularly those taking iodine, should not receive iodized oil

Particular attention should be given to the danger of the split of the chemical compound in the presence of the alkaline intestinal secretions If a considerable quantity of the oil is swallowed a cathartic should be administered to hurry the passage of the oil

The potential reduction in vital capacity, as a result of the introduction of the oil, should be kept in mind in choosing patients to receive the oil and useless large quanti-

ties should not be employed for this reason if for no other Archibald and Brown (24) point out the danger of the plugging action of the oil as it floats above the purulent secretion and theoretically causes the longer retention of infected material, and that the oil may operate as an obstruction to alveolar respiration While such a theory appears to be sound and should be considered in the evaluation of the bronchographic risk, neither of the above objections has proven practically to be serious, in our experience The reaction within the bronchus or alveolus does not seem to parallel that which occurs in the pericardium or spinal canal as reported in recent literature

The location to which the oil will gravitate is determined by the position of the patient during, as well as immediately after, the injection We have frequently been successful in visualizing the larger bronchi of all the lobes at a single effort To be sure the oil must be shifted from the lower to the upper lobes for the visualization of the latter whatever method of introduction is employed, except the bronchoscopic

method and possibly the tracheal catheter method

After visualization of the left lower bronchi the patient is placed on his left side and the head lowered to about 45 degrees, whereupon the oil will be seen to flow into

Over-filling of the bronchi should be avoided because of the resulting confusion of superimposed shadows. Technically good stereoscopic films in the postero-anterior projection, as well as a lateral projection, should be routine in order to evaluate par-



Fig 9 (left) Adhesive pericarditis and extensive cardiopulmonary fibrosis, illustrating the reduction of bronchial radiation, confirmed by autopsy.

Fig 10 (right) Sacular bronchiectasis, congenital, in the right lower lobe. This patient also presented a first degree cylindric bronchiectasis of the left lower lobe, acquired. Note transposition of the viscera. (Film reversed.) This is particularly interesting in support of the theory advanced by Sauerbruch.

the bronchi of the left upper lobe. Radiographs can be made while the patient's head is kept low. If he is turned on his right side and returned to the upright or semi-upright position, the oil will flow into the right lower lobe, finally, on returning him to a 45-degree inverted position, the oil will flow into the right middle and upper lobes.

The successful shift of the oil from one lobe to another requires complete co-operation on the part of the patient. A lessening of the tendency to cough will be effected by a gradual change in posture, for which manipulation the modern tilt-top table is ideal. When extensive shifting of the oil is contemplated a preliminary spray of from 2 to 4 cc of 1 per cent cocaine solution during deep inspiration will assist in preventing the cough reflex.

tial fillings. A slightly greater exposure of intensity should be used to assure registration through the heart shadow as well as the domes of the diaphragm. The bronchograph stands as an excellent example of the necessity for rapid exposure time in chest radiography in order that involuntary movements may be avoided.

Since a large amount of the oil is expelled by coughing, exposures should be made promptly after the injection. The normal lung retains a considerable quantity for days or even weeks and, in the event of re-examination, that fact must be borne in mind.

#### SUMMARY

1. The methods of introduction of iodized oil into the tracheo-bronchial tree are mentioned in outline and Singer's method described.

2 A classification of the indications for bronchography is given

3 A classification of the etiology of bronchiectasis is given

4 The etiology and pathology of bronchiectasis are discussed

5 The value of the bronchograph in pathologies other than bronchiectasis is pointed out

6 Contra-indications are mentioned

# CONCLUSIONS

Bronchography, by rendering visible the invisible, is an aid to the roentgenologist, and, by reason of its potential assistance, deserves more universal employment

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# EDITORIAL

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## CAN THE INTRAVENOUS INJECTION OF THORIUM DIOXIDE BE RECOMMENDED AS A SAFE DIAGNOSTIC AGENT?

The use of thorium dioxide as a diagnostic agent in the visualization of the reticulo-endothelial system extends over a period of several years. Its first demonstration in this regard was made in Europe, where it gained its greatest popularity, although a number of American radiologists reported with more or less enthusiasm having used thorium dioxide intravenously as a diagnostic agent. This method of examination, however, has not been generally accepted in this country, probably because it is not considered entirely free from danger when used intravenously to visualize the reticulo-endothelial system.

The principal reasons why the American radiologists have been reluctant in adopting the intravenous administration of thorium dioxide as a routine diagnostic measure has been that the organs of the reticulo-endothelial system readily absorb this substance and retain it for a period of months, probably for years or perhaps a lifetime. Thorium dioxide contains thorium, an element belonging to the radio-active group, which is capable according to some observers, of producing a definite biological effect

on tissue. It has been reported that an organ removed at postmortem, which had previously been made to absorb thorium by the intravenous injection of thorium dioxide, had the power of affecting a photographic plate when placed upon it. If all preparations of thorium dioxide in colloidal form have such radio-active properties, one can appreciate readily the damage they could do to organs of the reticulo-endothelial system in which they were retained for a period of months and perhaps years. It should be mentioned in this connection that certain observers have failed to confirm such findings. This discrepancy between the findings of various investigators is probably due to the fact that in one instance an old preparation of thorium was used and in the other a fresh one. It has been stated that the radio-activity of thorium in thorium dioxide increases with age. We must remember, therefore, that there may always exist a certain risk in using thorium dioxide undated. The manufacturer of a certain preparation of thorium dioxide (thorotrast) issues a caution to users of this preparation. He says:

'The clinical evidence to date indicates that thorotrast is a valuable contribution to roentgenography, and that no harmful effects may be expected following its use. We wish, however, to point out that the question as to the elimination of thorotrast from the body following intravenous injection and subsequent storage in the reticulo-endothelial system, is still under investigation, and no definite and reliable evidence that could be accepted as conclusive has been published.

Therefore in accordance with our established conservative policy, we recommend to the profession further study on the ultimate

fate of the intravenously injected thorotrast before such injection is accepted as routine practice in the x-ray visualization of the liver and spleen, etc."

We wish to commend the splendid spirit of this manufacturer in warning the profession to be conservative in the use of this preparation as a routine measure until such time as further reports shall show the harmlessness of its use intravenously, and particularly in regard to its elimination.

It should be recalled that many of the most useful diagnostic and therapeutic agencies were not accepted and used by the medical profession until long after they had been announced, and only after careful studies were made in order to determine their practical application and also their toxicity.

We should not be too hasty in condemning any new diagnostic or therapeutic agent without sufficient and thorough investigation, but, on the other hand, we should be extremely cautious and careful in giving approval of such an agent for routine use until it has stood the acid test of the experienced radiologists. We do not believe that sufficient study has been made of the radioactivity of thorium dioxide on tissue to determine just what changes are brought about. Until this is thoroughly investigated by competent and efficient research workers, we could not recommend its use intravenously as a routine diagnostic measure. However, the subcutaneous injections to visualize the lymphatic system have been shown repeatedly to be free from any local or constitutional reaction though it has been reported in one instance that marked changes were observed in a lymph node which had absorbed thorium. In many other similar nodes with thorium no such findings were observed. Therefore, there exists some doubt as to whether the changes just mentioned were the result of the absorbed thorium or due to other causes.

It is a great pity that thorium dioxide seems to have limitations as to its safety as a diagnostic agent. Its use has made possible the visualization of organs never before seen with the x-ray. Its potential diagnostic possibilities are almost beyond our conception. We have already seen in print its use as a diagnostic agent in retrograde pyelography, osteomyelography, pulmonary alveolography, nephrography, placentography, hepatography, splenography. It has also been used subcutaneously, intraperitoneally, interpleurally, and interpericardially to visualize portions of the lymphatic system in laboratory animals without any noticeable ill effect. Subcutaneous and intraperitoneal injections have also been made on humans without any subjective or objective symptoms. In these injections the thorium dioxide was absorbed by the lymph vessels and did not reach the reticulo-endothelial system as it would have done had it been intravenous instead. It has long been known that particulate matter and colloidal substances are absorbed by the lymphatic system, while the soluble substances are absorbed by the vascular system when injected subcutaneously. This explains why the subcutaneous injection of thorium dioxide cannot be considered harmful to the organs of the reticulo-endothelial system.

We are in entire agreement with the recent preliminary report of the Council on Pharmacy and Chemistry of the American Medical Association in regard to thorotrast.

"In view, therefore, of the very imperfect elimination of thorium dioxide, its fairly high alpha-ray activity, the possibility of further increase in radio-activity by partial conversion to mesothorium and radiothorium and the possibility of sensitization of tissues to roentgen rays, considering the short period during which patients have been kept under observation the Council voted that thorotrast be not accepted for intravenous administration" (*Four Am Med Assn* Dec 24, 1932, XCIX, 2183-2185).

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*Place of Meeting*—Palmer House, Chicago

*Date of Meeting*—September 25-30, 1933

## AMERICAN CONGRESS OF RADIOLOGY

The Executive Council of the American Congress of Radiology, scheduled for the Palmer House, Chicago, September 25-30, inclusive, has written to as many radiologists in the United States and Canada as are listed in the headquarters office and to many in Central and South America and abroad, inviting them to attend the Congress. Every radiologist who has received the invitation is urged to send in immediately his photograph and information for the Congress album, a copy of which will be given to each member, and to send in his registration blank *filled out*, and his fee in connection, in order that he may become a member of the Congress and receive free a copy of the beautiful book "Science of Radiology," which is being prepared in connection with the Congress. All arrangements are being made by the local committee and communications may be addressed to Benjamin H. Orndoff, M.D., Chairman, 2561 N. Clark Street, Chicago. Physicians and other scientists interested are invited to communicate with Dr. Orndoff.

It will be recalled that the four national radiological societies—the American College of Radiology, the American Radium Society, the American Roentgen Ray Society and the Radiological Society of North America—are meeting jointly this year and that the most comprehensive scientific pro-

gram ever given in the Americas is being prepared. Sessions will be held only until 2 P. M. each day, in order that the visiting physicians and scientists may attend the Century of Progress on the lake front. Ample accommodations will be arranged for at the Palmer House, Chicago, for all guests.

JAMES T. CASE, M. D.

*Chairman, Publicity Committee*

## AMERICAN CONGRESS OF RADIOLOGY

### A CENTURY OF PROGRESS

Chicago and its spectacular, fascinating "A Century of Progress," the finest extravaganza of achievement in a century, beckons invitingly to the hundreds of radiologists who will attend the American Congress of Radiology from September 25 to 30, inclusive, at the Palmer House, Chicago.

Tighty-two miles of exhibits, hundreds of stellar attractions in the realms of science, education, history, romance, fun, foods, music, thrills and adventure comprise the Fair. Built on 424 acres of made land, stretching for three miles along the shore line of Lake Michigan, nestled almost in the shadows of the big loop skyscrapers, A Century of Progress has been the world's busiest spot since the opening day. And it is the world's most colorful spot by day, and the world's brightest spot by night.

Brilliant, though softly blending, blues, reds, greens, golds, bronzes, silvers, blacks and whites—twenty-five colors in all, have been employed by artists to give the grounds a blazing kaleidoscopic spectacle. At night, miles of neon tubes, carefully concealed in direct lighting, flood the great expanses of the buildings with varicolored lights. Spotlights, color fountains and mushroom ground lights all add to the glory of the sight.

Telling the story of the growth of chemistry, physics, mathematics, geology, medicine, surgery and pharmacy graphically the

hundreds of exhibits in the Hall of Science are some of the most comprehensive at the Fair. Among other things, there are 60 physics exhibits, there is a \$10,000 "robot" who tells of the mechanical movements of his viscera by an illuminated "interior view" of himself. The earth sciences, appropriately epitomized by a "giant clock of the ages," are shown on the screen in the center of the dial, while the minute hand ticks off two billion years of earth history.

Exhibits in jewelry, cosmetics, office furniture, the graphic arts, mineral industries and textiles are housed in the General Exhibits group, while the General Motors Building has a complete assembling plant for automobiles. Long miles of exhibits in the Hall of States tell the wonders of Alaskan fisheries, of Hawaii's amazing fruits, California's beauty, Illinois' products. All in all, more than thirty states present their stories in surprising detail. The United States Government Building stands in the center of the horseshoe formed by the Hall of States, and exhibits showing the strides made in the various branches of government in the last 100 years are to be found.

Illinois, as host State to the Nation, has erected the only State building at the Fair, and its "welcome house" tells, among other things, the story of Lincoln through the comprehensive collection of Lincolniana to be found in three of the Host Building rooms. Stained glass windows, made by the re-discovered ancient Phœnician process, picture colorfully Illinois scenes, history, and accomplishments. There is an auditorium where lectures are held from time to time and the largest and most comfortable lounge in the Exposition takes up the entire south wing of the building.

Other feature attractions of the World's Fair are the exhibits of visiting nations as Italy, Japan, China, Sweden, Czechoslovakia, Ukraine, the beautiful reproduction of a Belgian village, and others. The Hall

of Social Science telling the Story of Man, the Radio and Communication Building, the Electrical Building, and the Home Planning Group are all particularly interesting. And so are the Mayan Temple, Chrysler Building, Horticultural Building, Hall of Religion, Firestone Building, the Sky Ride, the Dairy and Agricultural buildings, Fort Dearborn, and the Alpine gardens

#### FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

The Congress will be held in Zurich, under the presidency of Prof H R Schinz, July 24 to 31, 1934

According to Sect 3 of the "Rules and Regulations" the Congress may be attended by (1) Members of radiological societies in all countries, (2) persons introduced by such societies

The 32 countries which were represented at the Third International Congress of Radiology in Paris have been invited by the Organizing Committee to appoint delegates to the International Committee and to nominate a speaker to report on the organization of the cancer campaign in his country at the opening session

At the general meetings the following subjects will be treated

- X-ray diagnosis of bone tumors
  - Vasography
  - The development of pulmonary tuberculosis as seen radiologically
  - Radiation treatment of uterine carcinoma
  - Radiation treatment of malignant tumors of the mouth and pharynx
  - Radiation genetics
  - Mitogenetic radiation
  - Structure analysis
  - Identical physical measurement of the dose in x-ray and radium treatment
  - Hard gamma rays, cosmic radiation, earth radiation
  - Short wave therapy
- In addition the Sections for X-ray Diag-

nosis, Radiotherapy, Radiobiology, Radiophysics and Radiotechnic, Electrology and Heliotherapy will hold discussions and every member of the Congress is entitled to present a communication

During the Congress an exhibition of apparatus, photographic accessories, chemical products and scientific books will be on view (For details apply to A Strehl, Kilchberg, Zurich)

All radiological societies are requested to send as soon as possible a list of their members to the General Secretary, Dr H E Walther, Gloriastrasse 14, Zurich, Switzerland

PROF HANS R SCHINZ, *President*  
 DR RENE GILBERT, *Chargé de Cours, Vice-president*  
 P-D DR AD LIECHTI, *Vice-president*  
 PROF MAX LÜDIN, *Vice-president*  
 PROF A ROSSELET, *Vice-president*  
 DIRECTOR W MERIAN, *Treasurer*  
 DR HANS E WALTHER, *General Secretary*  
*The Organizing Committee*

#### WISCONSIN STATE MEDICAL SOCIETY

##### SECTION ON RADIOLOGY

The Ninth Annual Meeting of the Section on Radiology of the Wisconsin State Medical Society was held at Fond du Lac Wisconsin, in the Retlaw Hotel, May 19 and 20, 1933. The Chairman was J Newton Sisk, M D, of Madison, Wis

The meeting was one of the best this group has ever held—well attended by radiologists and clinicians from nearby towns. Janesville was selected for the next annual meeting, and the following officers were elected for the coming year: R L Troup, M D, of Green Bay, *Chairman*; F H Kuegle, M D, of Janesville, *Vice-chairman*; F W Mackov, M D, of Milwaukee, *Secre-*

tary-Treasurer, J E Habbe, M D, of Milwaukee, *Member of Executive Committee*

The active membership in this Section is composed of members of the Radiological Society of North America. This has been found to be a practical means of keeping the membership in the National Society intact

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### AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will hold its Eighteenth Annual Clinical Session in Chicago, with headquarters at the Palmer House, April 16-20, 1934

Announcement of these dates is made particularly with a view not only of apprising physicians generally of the meeting, but also to prevent conflicting dates with other societies that are now arranging their 1934 meetings

George Morris Piersol, M D, of Philadelphia, is President of the American College of Physicians, and will arrange the program of General Sessions. James B Herrick, M D, Emeritus Professor of Medicine of Rush Medical College, Chicago, has been appointed General Chairman of local arrangements and will be in charge of the program of Clinics. Mr E R Loveland, Executive Secretary, 133-135 S 36th Street, Philadelphia, Pa, is in charge of general and business arrangements, and may be addressed concerning any feature of the forthcoming session

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### MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in Rochester, Minnesota May 22, 1933, in conjunction with the annual meeting of the Minnesota State Medical Association. The following program was presented

- 1 Radiation Therapy in Non-malignant Conditions GAGE CLEMENT, M D, of Duluth  
Discussion by WILHELM STENSTROM, Ph D, of Minneapolis
- 2 Correlative Value of Clinical and Pathological Findings in Roentgenologic Diagnosis KANO IKEDA, M D, of St Paul  
Discussion by CHARLES G SUTHERLAND, M D, of Rochester
- 3 The Place of the Roentgenologist in the Private Practice of Medicine LEO G RIGLER, M D, of Minneapolis  
Discussion by E L TUOHY, M D, of Duluth
- 4 Childhood Tuberculosis R. G ALLISON, M D, of Minneapolis  
Discussion by C A STEWART, M D, of Minneapolis
- 5 Round-table Conference Roentgen Diagnostic Problems Conducted by B R KIRKLIN, M D, of Rochester

The following officers were elected for the coming year *President*, Edward Schons, M D, of St Paul, *Vice-president*, R G Allison, M D, of Minneapolis, *Secretary-Treasurer*, L G Rigler, M D, of Minneapolis

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### A WELL-KNOWN SOUTHERN EDITOR

The friends of Sidney C Barrow, M D, of Shreveport, La, are pleased to learn that he is Editor of the "Tri-State Medical Journal," the States sustaining it being Texas, Arkansas, and Louisiana

Dr Barrow has been a member of the Radiological Society of North America since the early days of the organization, and has been a Counselor for his State. Also, he is past president of the Louisiana State Medical Society, and is widely known throughout the South for his constructive work in general medicine and radiology. The "Tri-State Medical Journal" is to be congratulated upon securing Dr Barrow for the Editorship

## BOOK REVIEWS

**DIE DICKDARMSCHLEIMHAUT, IHRE NORMALE UND PATHOLOGISCHE FUNKTION IM RONTGENBILDE** PRIV.-DOZ. DR. WERNER KNOTHE, Leiter der Röntgenabteilung der II. Medizinischen Universitätsklinik der Charité, Berlin (Direktor Prof. G. v. Bergmann). Paper, 56 pages and 113 illustrations. Published by Georg Thieme, Leipzig, Germany, 1932. Price, 8 marks.

At the incitation of H. H. Berg, to whom greatest credit must be given for having brought the so-called internal relief roentgenology of the stomach and duodenum into the foreground, the author has undertaken to apply to the study of the mucosa of the large intestine, the same methods of investigation and principles of interpretation elaborated by Berg upon the groundwork of Forssell's pioneer observations. The mucosa of the alimentary tract is looked upon as meriting special attention and a special technic of investigation, not merely because the earliest as well as the most conspicuous macroscopic evidence of pathologic change is found there, but particularly because the mucosa itself is supposed to have a functional activity independent of the muscularis propria of the alimentary tract. Changes in this integral functional activity are alleged to be deducible from changes in the general appearance and arrangement of the mucosal folds. It is this latter point of view which is novel, for the importance of most careful scrutiny of the mucosal surface of all segments of the alimentary tract for evidence of organic change has always been realized by competent roentgenologists, though all of them have not insisted on roentgenographic data. The primary consideration in this monograph centers around the functional point of view. Almost half of the volume, however, is taken up with descriptive and illustrative material of true organic changes in the colonic mucosa as the method of diminished filling exhibits them.

The material is presented clearly and concisely, and there is a profusion of excellent illustrations. Dr. Knothe makes out a very good case for more widespread attention to the internal relief in the roentgenologic investi-

gation of the alimentary tract, particularly of the colon. Whether or not anything new in the way of roentgenologic signs or sign-complexes of organic disease will thus be forthcoming remains to be seen.

The method of diminished or incomplete filling should be looked upon, in the opinion of this reviewer, as a refinement of technic to complement and not to supersede older well established methods. It certainly has not made the roentgenologic diagnosis of gastro-intestinal disorders less complicated, and he who desires to set great diagnostic import upon minor changes in the mucosal relief will find a wide experience in the interpretation of these not uncomplicated mucosal manifestations of inestimable advantage.

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**LE PNEUMOTHORAX BILATERAL SIMULTANÉ (PNEUMOTHORAX, BILATERAL, SIMULTANÉOUS)** By M. ASCOLI and M. LUCACFR, Director and Assistant, respectively, of the Medical Clinic of the University of Palermo. Preface by F. DUMAREST. A volume of 104 pages, with 11 illustrations (Collection *Médecine et Chirurgie pratiques*, No. 54). Published by Masson et Cie, Paris, 1932. Price, 22 francs.

The authors present a monograph dealing with bilateral collapse therapy, reviewing the history of the indications for, and the technic of this procedure. It is stated that one of the authors proposed and applied the procedure whereby a pneumothorax was induced in the contralateral lung while the original pneumothorax was still effective, in collaboration with Fagioli in 1912, but no mention appears at this point, though included in the bibliography of Forlanini's work published in 1911. As contra-indications they mention cachexia and advanced toxemias, diffuse lesions, cardiac lesions, and extra-pulmonary complications. Pulmonary perforation is more frequent than in unilateral pneumothorax. Bilateral simultaneous pneumothorax is a sanatorium or hospital procedure and but rarely to be employed in the ambulant case.

In an extensive bibliography the reviewer notes many important omissions from the

North American literature, though the authors have furnished a fairly complete bibliography of the Continental literature. The book is an excellent resume and critique of a therapeutic procedure which has perhaps received insufficient attention.

LES REVEILS DE LA TUBERCULOSE PULMONAIRE CHEZ L'ADULTE. CONDITIONS DE LEUR POLYMORPHISME ANATOMO-CLINIQUE (The Awakening of Pulmonary Tuberculosis in the Adult). By PROF ÉMILE SERGENT, Membre de l'Académie de Médecine. A volume of 228 pages, with 27 illustrations. Published by Masson et Cie, Paris, 1933. Price, 34 francs.

Tuberculosis is an awakening of a childhood inoculation which, insufficiently strong or virulent to lead to death, has left a definite imprint—the virgin soil has become the tuberculized soil. Clinical observation proves that in the majority of cases this awakening occurs

without any intervening new contamination. When it takes place it expresses itself by the most diverse anatomical-clinical manifestations of which the univocal nature is attested only by the presence of the specific germ. How is it that this germ, solely by its presence, is able to produce so variable processes? What other conditions are able to exercise their influence on the clinical-pathological picture? In an effort to answer these and allied questions the author has assembled in his monograph a series of lectures and articles which he and collaborators have published in recent years. The rôle of the terrain, the antebacillary phase, the idea of activation, the relation of asthma and tuberculosis, the propagation of cervical lymphatic tuberculosis furnish interesting chapters. For one who lacks the time or opportunity to follow the wealth of material in the French literature this volume will furnish an excellent resume of the ideas of this author and his collaborators.

## ABSTRACTS OF CURRENT LITERATURE

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John R. Carty, M.D.	Paul C. Hodges, M.D.	Ernst A. Pohle, M.D., Ph.D.
I. E. Habbe, M.D.	E. T. Leddy, M.D.	Charles G. Sutherland, M.D.
Alan L. Hart, M.D.	H. C. Ochsner, M.D.	

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## HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Roentgen Sound Film. Berlin letter Jour Am Med Assn, April 1, 1933, C, 1049

A German technical institute for music has a radio experimental station in which Grosse has produced a film in which he synchronized roentgen films with corresponding sound records. One sees for example the diaphragm and the heart of an athlete working in rhythmic agreement. The eye and the ear follow the motions and sound associated with articulated words. Even when a person is silent, the sounds of his heart will be caught by the transmitter and will furnish an accompaniment to the roentgen films showing the pumping activity of the heart.

Since heretofore heart sounds and murmurs have been reproduced without distortion by the methods of Dr. Jacobson, he has been endeavoring to make records suitable for instruction purposes and secondly, to reproduce the heart sounds and the murmurs synchronously with the heart movements. From a number of single roentgen negatives, systole and diastole are selected and positives are prepared from them, the transitional movements between the two phases are represented artificially. Thus one procures a roentgen film of the heart action, by taking into account the time factors affecting heart action and the speed with which the film pictures are presented, one can figure out the number of "frames" required for the various phases. For the preparation of the individual frames, Jacobson has constructed a camera that represents a combination of photographic apparatus and cinema camera. The sound films that were first prepared and presented (a normal heart and a heart with aortic insufficiency, which in the roentgenogram shows a projecting left ventricle and aortic arch) were synchronized with the artificial heart sounds. These artificial sounds, presented a year ago, are especially suitable for a sound film because of their freedom from disturbing factors in connection with high amplification. For the purpose of synchronization, Jacobson uses an electrical cardiac tachometer which has a device geared according to the frequency of the heart beat and connected with the heart sound generator. In this manner the number of sounds or murmurs produced when the film is reeled off at a given speed is determined and thus a synchronism between the pictures and the sounds is produced. The didactic value of the new method is based on the simultaneous optical and acoustic record of the heart action under normal and pathologic conditions.

C. G. SUTHERLAND, M.D.

## HEMOPHILIA

Hemophilia. Carroll LaFleur Birch. Jour Am Med Assn, Nov 5, 1932, XCIX, 1566-1572

Hemophilia is usually classified under the hemorrhagic diatheses. The disease is manifested clinically by excessive hemorrhage which may be spontaneous or may follow slight injury and may occur any place in the body. Perhaps the most characteristic location of hemorrhage is into the joints. In the acute stage the joint is swollen, hot, and very painful. Usually there is no discoloration. After repeated hemorrhages there is atrophy and proliferation of bone, roughening of the articular surfaces with lipping, and osteophyte formation. In the chronic stage the appearance of the joints closely resembles that of proliferative arthritis. Hemorrhage into the epiphyseal line may interfere with nutrition and stunt the growth of the bone. Hemorrhage into the hip joint often leads to destruction of the head of the femur with consequent shorten-

ing of the leg. Probably no one with high-grade hemophilia escapes crippling of the joints and bones. Hemophilia is the most highly hereditary of all hereditary diseases. Treatment has consisted of the administration of preparations of ovary. On the whole, the results have been satisfying.

C. G. SUTHERLAND, M.D.

### HODGKIN'S DISEASE (THERAPY)

Radiotherapy for Hodgkin's Disease and Lymphosarcoma. Arthur U. Desjardins. *Jour. Am. Med. Assn.*, Oct. 8, 1932, XCIX, 1231-1236.

The clinician can seldom distinguish one condition from the other. Mallory collectively designated this group of diseases by the term "lymphoblastoma." The pathologic features are often far from characteristic, absolute differentiation being difficult or impossible. As a diagnostic measure the radiotherapeutic test is often invaluable.

The only effective method of treatment is radiotherapy and irradiation by means of the roentgen ray which has many advantages over radium. It is often advisable to irradiate many different areas. Lymphocytes are the most radiosensitive of all cells, and rays of medium wave length are more useful in the long run. Another important reason against short wave length rays as a routine is that blood supply may be seriously injured in cases in which many areas must be irradiated.

Roentgen treatment may be given by one or two methods. Irradiation may be confined to regions in which enlarged nodes are palpable or more general at the outset and later restricted to regions in which fresh lymphadenopathy appears. The latter is the better plan.

C. G. SUTHERLAND, M.D.

### LIGHT THERAPY

A New Method of Light Therapy in Tuberculosis of the Larynx. A. J. Cemach. *Strahlentherapie*, March 9, 1932, XLIII, 547-564.

The author describes in detail a special quartz mercury vapor lamp which can be inserted into the larynx and which is especially suitable for the treatment of tuberculosis. The indication and prognosis in this type of case are related followed by a discussion of the effect of the light on the pathologic process. General therapy is important as a supplement to the local irradiation.

FRIST A. POHL, M.D., Ph.D.

### NEVI

The Irradiation Treatment of Red Birthmarks. Experiences in Over 200 Cases. Ernst Kromayer. *Arch. and Cutan. Rev.*, August 1932, XXXVI, 524-527.

The author who has been treating red birth-

marks by irradiation with roentgen rays, radium, and light rays since 1906, discusses his experiences in the three anatomic types of this condition.

Red birthmarks may be arterial, capillary, or venous in origin. Arterial nevi are frequently not present at birth but appear during the first weeks of life as red points which grow to the size of a coin and present a light red protuberant surface. Capillary nevi are usually smooth and flat, but sometimes are protuberant. Among the flat nevi may be differentiated superficial ones, lying in or under the papillary body, and deep ones involving the whole thickness of the cutis propria down to the subcutaneous tissue. Venous birthmarks arise either from the papillary body or from the subcutaneous tissue and consist of dilated capillaries and veins lying in a soft, sparse connective tissue.

In the light irradiation treatment the author employs the blue light of the water-cooled Kromayer lamp, with careful compression of the skin by massive quartz layers. The maximum exposure is one-half hour and, since the pain from the exposure develops the next day, it is considered advisable to treat the skin areas as a whole, whenever possible.

The dosage of roentgen rays and radium is one erythema dose, divided into six doses, each one-sixth SED administered on consecutive days. In small children, from 2 months to 2 years old, the irradiation dose of light, roentgen rays, and radium is decreased to one-third, one-half, or four-fifths of the adult dose.

In the treatment of arterial nevi radium is the method of choice, for not only are the superficial vessels acted upon but also those penetrating through the cutis. While one course is usually sufficient, in some cases the irradiation may have to be repeated after an interval of one month to prevent a recurrence of the nevus. Small nevi may be successfully removed by the cautery tip, but in the case of larger nevi, an arteriole may be overlooked and a recurrence would result. An additional disadvantage especially in children, is that the application of the cautery point is painful. While the results of light treatment may cause an almost complete disappearance of the nevus, after subsidence of the inflammatory reaction, individual red points (which are the small arterioles) are noted in the irradiated area. These in the course of weeks, increasing rapidly in size. The roentgen ray acts similarly though not as effectively as radium and cannot be applied so conveniently.

Superficial capillary nevi are easily destroyed by a single intensive compression irradiation with the blue light of the Kromayer lamp. However, usually, in one of the larger nevi there is involvement of the deeper vascular as well as superficial parts. The author therefore advises the primary irradiation with the blue light compression treatment to be followed in from two to three weeks later by an erythema dose of radium, divided into six consecutive days.

In some cases even this form of therapy is unsatisfactory, for the vessels of the nevus are only slightly diminished

Small superficial venous nevus can be removed by operation, corrosion, cold, electrolysis, and alcohol injection, and by roentgen or radium irradiation. Since irradiation is painless, it is preferred to the other forms of therapy. In the treatment of extensive and deep-seated venous nevus, roentgen and radium irradiation are the methods of choice, and in some cases the only possible method of treatment.

J. N. ANÉ, M.D.

## THE PELVIS

Contribution to the Roentgenologic Measurement of the Pelvis and Fetal Head in *Utero*. S. Ribbing. *Acta Radiologica*, 1932, XIII, Fasc. 5, pp. 591-598.

In pelvimetry one is concerned with the size and shape of the pelvis and the fetal head. The conjugata vera lies in the plane of a line connecting the upper border of symphysis and the spinous process of the fifth lumbar vertebra. One may measure this distance on a film of the pelvis made with the patient in a half-sitting posture. A perforated metal plate placed in the same plane as the conjugata, may be used or the patient may be placed so that this plane is parallel with the film, allowing for the distortion.

The conjugata vera may be measured even more accurately on a lateral film made by the Guthrum method. This film also gives an excellent idea of the shape of the pelvis. It is probably advisable to make both the anteroposterior and lateral films in each case. Such a procedure is much simpler than the stereoscopic methods by which the pelvic measurements are estimated.

The author believes that the simplest method of measuring the transverse diameter of the pelvis is orthodiagraphy by the Moritz method. This can be done with the patient lying on her back. The author uses a small metal ring fastened directly in line with the focal spot on the aluminum filter and a small diaphragm; he adjusts the end point of the transverse diameter to coincide exactly with the center of the metal ring and obtains in this way, on one film, two small pictures which coincide exactly with the two end points of the desired diameter. The cassette is held throughout the examination in exactly the same level above the patient's pelvis.

The irregular shape of the fetal head and the fact that its distance from the film is not known make accurate measurement of the head difficult. The author advises orthodiagraphy for the measurement of the head also.

A. L. HART, M.D.

## PEPTIC ULCER (THERAPY)

The Relation of Alkalosis to Peptic Ulcer. Henry A. Kafska, Louis Schwartz and Alexander W.

Kruger. *Jour. Am. Med. Assn.*, Nov. 5, 1932, LVIII, 1582-1586.

Excessive doses of alkalis were administered to 61 patients with peptic ulcer, by a method in which initial small doses were followed by progressively larger doses until there ensued a complete cessation of symptoms. The carbon dioxide combining power of the blood plasma and blood chlorides did not reveal any evidence of alkalosis in any of these cases. Patients with renal disease, also allergic persons, were treated more cautiously by this method. Patients with pyloric obstruction and extreme degrees of gastric hypotonia were not treated by this plan. Two patients, treated according to the Sippy method, developed severe symptoms of alkalosis and showed definite biochemical changes. In order to minimize the danger of alkalosis resulting from excessive alkaline therapy, more attention should be directed to the method of administration as well as to the type of patient to receive this form of therapy.

C. G. SUTHERLAND, M.D.

## RADIATION

The Influence of Thorium X on Human Leukocyte Cultures with Particular Consideration of the Effect of Benzol. G. Wallbach. *Strahlentherapie*, 1933, XLVI, 675.

After cultures of human leukocytes were exposed to thorium X the author observed a marked inhibition of the migration and growth of the various cell elements. In some cases cell death occurred, particularly among the granulocytes and to some extent among the lymphocytes. There seems to be a definite relation between dose and effect. The observed changes were undoubtedly due to the radiation emitted by thorium X. When compared with the effect of benzol on the same cell cultures a marked difference was seen between the changes due to benzol and to thorium X.

FRANK A. POHLE, M.D., Ph.D.

The Effect of Roentgen Rays on the Carbohydrate Metabolism of Normal Animal Tissues. T. Ullmann. *Strahlentherapie*, 1933, XLVI, 705.

The testicles of rats and the liver of guinea pigs were exposed to roentgen rays by carefully shielding the remaining part of the body (135 kV, 3 mm Al, 600 r and 1200 r). The glycogen content of irradiated rat testicles was about 58 per cent lower than in non-irradiated testicles. The glycogen cleavage in irradiated liver was definitely lower than in non-irradiated liver. The author assumes that these observations may be explained primarily by changes in the cell structure.

FRANK A. POHLE, M.D., Ph.D.

# RADIATION INJURIES

Studies as to the Indications and the Results of Treatment with Small Doses of and Temporary Sterilization by Roentgen Rays Its Significance for the Offspring Based on the Clinical Material of the Women's Clinic, University of Freiburg D Jost *Strahlentherapie*, 1933, XLVI, 601

The author analyzes 141 cases treated during 1919-1928 for abnormalities of menstruation Included in the group were also pelvic inflammatory disease and uterine fibroids Small doses of from 6 to 10 per cent HED (measured on the skin) produced 50 per cent cures in 36 cases of amenorrhea Out of 23 cases of oligo- and hypomenorrhea, 54 per cent were benefited Out of 17 cases of menorrhagia, 35 per cent responded well Out of 13 cases of adnexitis 5 were benefited Four out of six patients with dysmenorrhea were improved Two patients who complained of sterility were also treated In one case a pregnancy occurred four months after treatment, in the other there was no benefit Temporary sterilization was used only in cases of menorrhagia, adnexitis, and uterine fibroid It was impossible to foretell the duration of amenorrhea from the applied dose Some patients who did not receive the sterilization dose but much less, had permanent amenorrhea, with others, it lasted from eight weeks to eight years In one case 25 per cent of the HED effective in the ovaries did not produce amenorrhea

Very interesting was the follow-up of the treated cases 37 had pregnancies, with 48 deliveries and 15 abortions Of the 48 children two were stillborn 3 children died during the first year One of these had celiac disease which might have been due to a radiation injury Of the 43 surviving children, one presented delayed development not learning to talk until the age of three and a half years

The application of small doses of roentgen rays to the ovaries of women during the child bearing period is, therefore, not recommended

ERNST A POHLE, M D Ph D

A Case of Injury to the Offspring Due to Roentgen Rays Stefan Biró *Strahlentherapie* 1932, XIV, 549-552

The author reports a case of a woman 32 years old who received x ray therapy over the lower pelvis because of irregular menstruation Pelvic examination three months later led to the diagnosis of a uterine tumor Because of the possibility of an ectopic pregnancy in a uterus gravidus the patient was admitted to the hospital three months after this examination A child 39 cm long weighing 1550 grams was born with a head circumference of 25 centimeters Although the child gained in weight the author believes that the microcephaly was due to the irradiation carried out during the mother's pregnancy

ERNST A POHLE, M D Ph D

The Occurrence of Roentgen Pleuropneumonitis in Treatment of Breast Cancer R H Fike *Am Jour Roentgenol and Rad Therapy*, April, 1932, XXVII, 509-512

The term "roentgen pleuropneumonitis" is used to describe all undesirable radiation effects in the chest wall, pleura, and lungs Clinically the condition is characterized by a harsh, unproductive cough, with varying degrees of dyspnea Roentgenologically the condition resembles the early stage of massive collapse, the diaphragm on the affected side being elevated and fixed, the mediastinal contents displaced toward the involved side, and the entire lung field hazy Later the haziness clears up and a varying degree of fibrosis can be recognized

On reviewing the case records of 670 patients who had received deep therapy to the extent of 4,170 treatments over the thorax, no cases of clinical roentgen pleuropneumonitis developed, however, two cases receiving repeated irradiation and later coming to necropsy showed microscopically adhesions between the lung and pleura under the area treated and distinct atelectasis in the adherent portion of the lung, the alveoli being compressed and the walls thickened and swollen No massive connective tissue proliferation or changes in the smaller bronchi were noted A case is also presented of a patient who had had repeated superficial radiation over both sides of the chest and who one year later showed the roentgen picture of right-sided pleuropneumonitis but whose clinical symptoms were relatively slight

J E HANNE, M D

# RADIUM (THERAPY)

Treatment of Malignant Tumors Advantages of Weak Heavily Filtered Radium Needles Charles L Martin *Jour Am Med Assn*, Nov 5, 1932 XCIX, 1587-1592

Certain tumors such as lymphosarcomas and masses of leukemic glands, may be melted away rapidly by irradiation Other forms, such as adenocarcinomas, respond less rapidly Normal tissues vary in their reaction to irradiation just as do malignant cells The problem involved in safely radiating only the abnormal structures becomes difficult in the deeper parts of the body Irradiation of great penetrating power and short wave length has much less necrotizing effect and a greater selectivity for radiosensitive cells than irradiation of less penetrating power and shorter wave length The selectivity of radiant energy for radiosensitive cells is increased when the duration of the exposure is increased with a corresponding decrease in intensity Regard put these principles into practice by preparing long heavily filtered platinum needles containing small amounts of radium for use in implantation therapy The low intensity needles have been used success

fully in many locations—mouth, breast, rectum, prostate, vulva, vagina, cervix, urethra, and larynx. The rapid regression of malignant tumors and the rapid healing that follows their regression are strong arguments for this method. Roentgenograms made following implantation reveal errors of distribution which may be easily corrected. The trend toward higher voltages and heavier filters in roentgen therapy is based on the principles laid down in this paper, and it is to be hoped the results obtained will be as satisfactory as those observed following the changes in radium technique.

C. G. SUTHERLAND, M.D.

Radium Therapy of Nasopharyngeal Fibromas  
Angelo S. D'Emidio. *Archivio di Radiologia*,  
Sept-Dec, 1932, p. 789-795.

The author reports two cases treated by him both recurrences, and in both of which a good and lasting result was obtained. He advises direct application through the nasopharynx of heavily filtered radium, giving a dose of from 20 to 30 mc in about ten days. He feels that radium therapy is superior both to operation and diathermy.

E. T. LEDDY, M.D.

### ROENTGEN RAY (INDUSTRIAL APPLICATION)

The Decomposition of Benzophenondiazid and a Few Other Nitrogen Compounds under the Influence of Roentgen Rays. G. Cronheim, S. Goetzky, and Paul Günther. *Strahlentherapie*, Feb. 10, 1932, XLIII, 379-389.

Benzophenondiazid gives off nitrogen when exposed to roentgen rays of various wave length. In the range of 0.6 to 1.54 Å, Glocker's theory concerning the chemical effect of roentgen rays was confirmed. This means that only that part of the radiant energy transformed into secondary electrons is responsible for the chemical reaction. In order to free one mol of nitrogen, 25,000 calories of secondary electrons are necessary for the range of wave length mentioned above.

ERNST A. POHLE, M.D. Ph.D.

### THE SKIN (THERAPY)

The Effect of Combined Ultra-violet and Roentgen Radiation on the Skin. Lorenzi Angelo. *Archivio di Radiologia*, March-April, 1932, VIII, 273-280.

The author tested the effects of various combinations of ultra-violet and x-rays on the skin and found that excessive erythemas were produced. He therefore, feels that any area which has had recent ultra-violet treatment should be irradiated with roentgen rays exercising great caution.

E. T. LEDDY, M.D.

### THE THYMUS (DIAGNOSIS)

The Thymus and its Function. Editorial Jour. Am. Med. Assn., Nov. 19, 1932, XCIX, 1782, 1783.

The functions are still a mystery—its anatomy is controversial. Generally, it is believed the gland is in some way correlated with the process of growth and that after puberty it undergoes a gradual atrophy and involution. There is also presumed to be some reciprocal relation between the thymus and the reproductive glands. Klose and Vogt hold that the thymus is concerned especially in the synthesis of nucleic acid. Hammar concludes that the variations in the lymphocytic content of the thymus and the variations in the Hassall corpuscles constitute the essential morphologic changes associated with thymic function. Every theory as to the physiology of the thymus must explain these histologic changes. There is apparently an increase in the development of Hassall corpuscles in various toxic conditions except intoxication by drugs. Since the thymus is essentially an epithelial organ filled with leukocytes, Hammar thinks it exerts an antitoxic action against certain poisons, and suggests the Hassall corpuscles are the morphologic exponents of this antitoxic function. In thymic death, he studied the gland and concluded the thymus was not directly concerned. The apparently large size of the gland was due to the absence of accidental involution. Bastenier concludes that the Hassall corpuscles are not organs of internal secretion, they merely phagocytize the thymic chromatin that has disintegrated. Various alterations and diseases such as trauma, operative shock, and acute infections, seemed to induce a rapid, massive disintegration of thymic cells and the appearance of numerous young Hassall corpuscles. Starvation and chronic infectious diseases provoked a relatively slow thymic involution of the sclerotic type found in inanition. Diseases accompanied by starvation seemed to offer the best conditions for the gradual involution of the thymus, associated with "epithelial reversions." In two cases of exophthalmic goiter the thymus gland showed a hyperplasia due to accumulation of thymic cells and evidence of a recent crisis of nuclear disintegration. The disappearance of thymic cells in the course of pathologic involution is not due to their emigration but to their destruction *in situ*. The development of Hassall corpuscles is linked with the destruction of the thymocytes. Involution of the thymus is a simple reaction occurring in any involvement of the general condition and is not due to any particular disease or intoxication. He found no basis for the theory that the thymus develops an antitoxic secretion but he does find evidence in favor of the nucleus regulation theory. In the course of pathologic involution as well as in physiologic involution the thymus shows the same reactions of thymocholasis. Grigore has studied the effects of x-rays on the thymus in adults and in embryos particularly from

the point of view of radiosensitivity of the small thymic cells, the nature of the phagocytic process, and the mechanism of reparation. One school believes the thymic cells are formed by the immigration of leukocytes into the thymus, the other urges that the large epithelial cells are the ancestors of the small thymic cells. Grégoire concludes the small thymic cells develop from the primitive epithelial cells within the thymus and that there is no immigration of exogenous cells. This transformation occurs through a type of diminutive mitosis especially characteristic of the thymus (elassosis) first described by Dustin. The appearance of radiosensitivity in the small thymic cells of the embryo corresponds with the stage of diminutive mitosis which gives origin to the small thymic cells. X-rays selectively destroy the small thymic cells on their appearance. Gregoire reports that pregnancy induces in the thymus a transient reversible involution in an organ already undergoing physiologic involution more or less pronounced according to the age.

In the embryo as well as in the adult, this investigator observed tissue continuity between the thymus and the parathyroid glands, as well as the direct formation of parathyroid tissues at the expense of thymus epithelial cells. He has also called attention to the absence of Kurloff bodies in the thymus cells of the normal embryo. They were observed in considerable numbers in the thymus of the pregnant animal after irradiation. The Kurloff bodies are merely degenerative figures. Cellular metaplasia is a phenomenon peculiar to the thymus and is produced by frequent changes in the cortical region, and by the absence of a pathway for the elimination of cellular debris.

C G SUTHERLAND, M D

### TUBERCULOSIS (DIAGNOSIS)

Atelectasis in Pulmonary Tuberculosis. Barnett P. Strickman. Jour Am Med Assn Nov 12 1932, XCIX, 1666-1670.

Experimental work has brought forth incontrovertible proof that the determining cause of atelectasis in any pulmonary area is the complete obstruction of its draining bronchus. Bronchoconstrictor reflex, diaphragmatic paralysis, and the vasomotor reflex have no etiologic relation to atelectasis.

Contributory factors are an accumulation of viscid secretion in the bronchial tree (most important), inflammatory processes in the smaller or larger bronchi, interference with the function of the ciliated epithelium, pain either in the chest or in the abdomen restricting the respiratory effort and the need of narcotics to relieve the pain which abolishes the cough reflex. Atelectasis may result from pressure of lymph nodes on the bronchi. Multilobular or massive atelectasis of the lung in phthisis is uncommon. The acute form is best seen in patients with hemoptysis in whom a large blood clot may

occlude a bronchus. In chronic massive atelectasis reliable data are not available to show whether this providential atelectasis and the subsequent cirrhosis are due to an old primary plugging of the main bronchus or to multiple lobular atelectasis which has slowly progressed so as ultimately to involve the larger and main bronchi. Massive atelectasis of the lung in phthisis is most often confounded with extensive unilateral fibrosis. The roentgenologist is in no position to make a diagnosis of the underlying pulmonary process in cases of this type, and should not be asked to do so.

Lobular or confluent lobular atelectasis is of the most frequent occurrence in all stages of pulmonary tuberculosis. The narrowing of the interspaces at the site of the lesion, the deviation of the mediastinum toward the lesion, and the elevation of the homolateral leaf of the diaphragm in early cases are not due to fibrosis (of slow evolution), as has been hitherto supposed, but to lobular atelectasis which develops with great rapidity in any tuberculous pulmonary area. The greater frequency of lobular or confluent lobular atelectasis in pulmonary tuberculosis appears to indicate that it is one of Nature's ways of initiating fibrosis in the involved area.

Lobar multilobular atelectasis in the course of artificial pneumothorax is apparently a beneficial process and leads to a better collapse and early fibrosis of the treated lung.

C G SUTHERLAND, M D

### TUBERCULOSIS (THERAPY)

The Treatment of Tuberculosis of the Female Genital Organs. F. Gál. Strahlentherapie 1933, XLVI, 617.

During the last ten years the author has seen 53 cases of tuberculosis of the female genital organs. Those treated by roentgen rays received through 0.5 mm Zn at 30 cm FSD about 25 per cent HED per area (four fields over the abdomen). Forty-two patients were treated surgically and 13 received irradiation. In 11 of these 13 cases the diagnosis was verified by laparotomy. Nine patients could be followed up for a period of from one to four years. One died from general tuberculosis one year after the treatment, while all the others remained well. In addition to the x-ray treatment, ultra-violet therapy was used. In the author's opinion, it is difficult, however, to evaluate the influence of ultra-violet rays on this disease.

ERNST A. PORTE, M D, Ph D

The Question of Roentgen Therapy in Tuberculosis of the Female Genital Organs. H. Dworzak. Strahlentherapie 1933 XLVI 633.

The author briefly discusses the status of roentgen therapy in pelvic tuberculosis in women. He then reports one case in which a histologic examination of the organs was carried out after irradiation. The

woman, 22 years of age, was admitted with a histologically proven case of tuberculosis of the cervical os. She received 9 x-ray treatments between June, 1931, and March, 1932. The fields were applied over the anterior abdomen or the vulva, 110-200 r each time. At the end of that period the general condition was excellent but locally there was still evidence of the disease. Hysterectomy was, therefore, performed in June, 1932. A photograph of the specimen and photomicrograms of the sections are shown. The disease had partly healed and beyond a certain zone there was definite active tuberculosis. Six months later the patient returned with a recurrence in the stump of the vagina. This is being treated now by roentgen rays. The author concludes that neither irradiation nor surgery produced a complete cure in this case.

ERNST A. POHLE, M.D., Ph.D.

Liver Meal in the Treatment of Amyloidosis in Surgical Tuberculosis. Brainerd H. Whitbeck. *Jour. Bone and Joint Surg.*, January, 1932, XIV, 85-92.

Because liver meal administered to combat the anemia of chronic tuberculosis appeared to have a favorable influence upon amyloid degeneration of the liver and spleen, it has been used in the Neponset Beach Hospital in the treatment of seven cases of amyloidosis.

Concentrated powdered whole liver was used in doses of 4 grams three times a day. One child died of pulmonary lesions early in the course of treatment; a second, after showing evidence of resorption of amyloid material, died (possibly from portal obstruction there being no autopsy). The remaining five have been treated for two years and though a positive Congo red test persists, indicating that much amyloid material remains in the body, still the liver and spleen are smaller, ascites and venous distention have disappeared, and the general condition of the patients is frankly improved.

PAUL C. HODGES, M.D.

## TUMORS (DIAGNOSIS)

Tumors of the Adrenal Gland. Report of Two Cases of Paraganglioma of the Adrenal Gland. Joseph A. Lazarus and A. A. Eisenberg. *Jour. Urol.* January, 1932, XXVII, 1-26.

Tumors of the adrenal are classified and described as indicated by a general survey of the literature. These tumors are rare. The most important growths from a clinical and pathologic viewpoint are those arising from the epithelial component of the gland.

The outstanding features of the tumors involving the adrenal cortex are the associated sex changes which have been designated as the adrenal-genital syndrome and are most frequently seen in female children.

As a result of the fact that the adrenal medulla

is an offshoot of the sympathetic nervous system, tumors arising from this part of the gland bear a very close resemblance to tumors of the sympathetic system, and, the degree of malignancy shown by these newgrowths varies inversely with the state of maturity of the medullary cells. The more mature the cells, the more benign the growth.

Paraganglioma is a tumor composed entirely of mature chromaffin cells of the adrenal medulla; is usually benign, and unlike all other adrenal tumors occurs only in adults.

Adrenal tumors have a tendency to cause irreducible renal ptosis.

Fever and skin pigmentation are suggestive symptoms.

The finding of a large ovoid shadow in the roentgen plate situated over a ptosed and rotated kidney is suggestive of an adrenal tumor.

The authors present two cases of paragangliomas, both of which occurred in women 58 years of age. The x-ray films in one of them led to a tentative diagnosis of an adrenal cyst, while in the other, the presence of the paraganglioma was clinically overshadowed by the co-existing carcinoma of the thyroid and was discovered only at autopsy.

A review of the literature seems to show that the second case is the only one on record of a paraganglioma metastasizing in other organs, thereby indicating that this tumor possesses potentially malignant properties.

A rather complete bibliography of this type of tumor accompanies the article, together with microscopic sections and roentgenograms of the two cases reported.

DAVIS H. PARDOLL, M.D.

Roentgenology as an Aid in the Diagnosis and Localization of Brain Tumors. B. A. Moyness. *Med. Bull. Veterans' Administration* February 1932, VIII, 99-104.

The author discusses the value of roentgenology as an aid in the diagnosis and localization of brain tumors, and agrees with Holmes that roentgenology of the skull, its contents and adjacent structures constitutes a special field in the practice of radiology.

The statistics of Cushing's Clinic showed that of a total of 1146 verified intracranial tumors, four main classes made up 88 per cent of the cases. Of these four groups an average of 37 per cent were localized by the x-ray. Gliomas constituted 43 per cent of the series and of these from 10 to 12 per cent were recognized by the x-ray due to calcification within the tumor. The pituitary tumors which comprised 24 per cent of the series occurred as common adenomas and the less common congenital cysts arising from the remnants of Rathke's pouch. Of the third group of meningiomas which constituted 12 per cent of the cases 50 per cent were identified and localized on roentgenograms. The fourth

group, the neurinomas or neuromas of the acoustic nerve, comprised 9 per cent of the series

The roentgen findings in brain tumors depend upon the size, type and location of the tumor. The author believes that co-operation between the roentgenologist and clinician is of the greatest importance. Stereoscopic films in the lateral position of both sides of the head and antero-posterior views should be made. Roentgenograms made with the technic of Pancoast, by flexing the head on the body so as to incline it on the film holder 20 degrees and directing the incident ray vertically downward, are of value in studying the middle and posterior fossae, including the petrous bones. A well qualified roentgenologist who knows the normal and the variations from the normal anatomy of the skull is essential.

The adenomas of the sellar group of tumors produce an alteration in size and shape of the sella turcica as demonstrated in 90.8 per cent of tumors studied by J. Gershon-Cohen. The dorsum sellae as a rule remains intact, although thinning or even fracture may occur. The depth rather than the antero-posterior diameter is first increased in the early stages. Some pituitary tumors tend to grow laterally and do not produce changes in the sella turcica. A pituitary carcinoma may erode any portion of the sella or may invade the sphenoid sinus. Increase in intracranial pressure does not occur until the pituitary tumor has enlarged sufficiently to obstruct the third ventricle.

The roentgen findings of cerebral tumors may be divided into direct and indirect signs. The direct roentgen signs are as follows: Calcification within the tumor, localized bone atrophy, localized bone hyperostosis usually seen as a result of meningiomas and due to spicule formation following dilatation of the blood vessels and bone destruction. This hyperostosis may resemble an osteogenic type of sarcoma.

The indirect signs of cerebral tumors resulting from increased intracranial pressure are of more value in the diagnosis of gliomas. Convolutional atrophy, changes in the dorsum sellae, increased prominence of the diploe vessels, widened arterial grooves and separation of the sutures in young children indicate increase in the intracranial pressure.

Cerebellar angle and posterior fossa tumors are best studied on roentgenograms made by the technic of Pancoast. The indirect signs which aid in the diagnosis of tumors of this group are as follows: Increased convolutional markings, which occur three times as often in this type of tumor as in cerebral types; atrophy of the dorsum sellae; displacement of the pial shadow.

The author is of the opinion that encephalography and ventriculography should not be employed until the patient has been carefully and thoroughly studied neurologically and roentgenologically. If such

a complete examination fails to reveal the presence of an intracranial tumor, then encephalography and ventriculography should be resorted to. Encephalography is contra-indicated in cases in which the spinal-fluid pressure is greater than 20 mm of mercury in the reclining position. Ventriculography requires an operative trephine of the skull and has greater risk attached to it, but it displays the ventricular system better than does encephalography.

J. N. ANÉ, M.D.

Roentgenologic Manifestations of Giant-cell Tumor. B. R. Kirklin and Claude Moore. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1932, XXVIII, 145-150.

For the 20-year period ending in 1929, 110 cases of giant-cell tumor were observed at the Mayo Clinic, 86 of these being proven by either operation or biopsy. In this group two roentgenologic types were encountered with about equal frequency. One group was characterized by a trabeculated cystic expansion of the end of a long bone, the cortex being intact, while the other group was commonly in the same location but showed a more homogeneous and complete lysis of bone and the cortex often broken through and partially destroyed. The pathologic changes grossly were as might be expected from the roentgen appearance, the second group showing a tumor space filled with a fluid, gelatinous mass of softer consistency than the tumor tissue the x-ray appearance of which was characterized by trabeculation. Microscopically, however, the picture was the same.

It is suggested by the writers that the second group may represent merely a later stage of the more commonly observed and described lesion. It is important to differentiate the second type from primary sarcoma or massive metastatic tumor.

J. E. HANNE, M.D.

Ulcer in a Thoracic Stomach. Very Small Benign Gastric Tumors. Lymphogranulomatosis of the Stomach. Unusual Prestenotic Appearance of the Small Intestine. Lipomas of the Colon. Theodor Barsony and Ernst Koppenstein. *Röntgenpraxis*, October 1932, IV, 818-828.

A thoracic stomach is a rare condition but is readily demonstrable by roentgen examination. An ulcer in it is exceedingly difficult to find. Three cases have been described to which the authors add another. In their case, in that portion of the stomach which was compressed by the spine when the roentgenogram was taken, a niche was evident. The patient's symptoms were mostly due to the ulcer, inasmuch as most of them disappeared after the institution of an ulcer regime.

Since introduction of the relief examination of the gastric mucosa, small benign gastric tumors are rarities no more. The decision between small benign



and malignant growths can often be made only after repeated examinations, with intervals of time between. In one case described, the sharply limited, small filling defect remained of the same size during four years, which proved its benign nature.

Two cases of gastric lymphogranulomatosis (Hodgkin's disease) are described, in one of which surgery proved the correctness of the diagnosis. Roentgenologically it presents the same appearance as a cancer and cannot be differentiated from it. In young individuals with a cancer-like roentgen appearance of the stomach, one should think also of syphilis and Hodgkin's disease, especially when, as in this case, the gastric acidity was found to be normal.

An interesting appearance of the prestenotic small intestine is described. A flat film showed fluid levels with gas distention of portions of the ileum. When a small amount of barium had been given, some small intestinal loops were found to be distended and presented an unusual honeycomb appearance. There were multiple regular filling defects the size of a pea throughout the barium-filled ileum, which could be seen for 48 hours after the barium meal, the appearance being similar to a polyposis of the colon. Operation showed an obstruction in the terminal ileum, the peculiar appearance of the ileum being explained by a tremendous number of grape, apple, and orange seeds which filled the dilated loops of the bowel.

Lipomas of the colon are rather rare and only two have been described in the roentgenologic literature as far as the authors could find. Two additional cases are described by them. The roentgenologic findings in one case, between the colon descendens and the sigmoid, were that of a carcinoma, partly because there was also a slight invagination. The second lipoma in the hepatic flexure was well circumscribed and smooth in the roentgenogram, which was considered as an indication of its benign character. In both cases, surgery and microscopic examination revealed the tumors to be lipomas.

H. W. HEFKE, M.D.

Malignant Testicular Tumors. Louis Bollag. Schweiz. med. Wchnschr., April 30, 1932 LXII 419 424.

The author discusses three cases of malignant testicular tumor and reviews some of the literature. The relatively frequent development of malignancy in undescended testicles is discussed. There is also

a close association between injury and the development of malignant changes. The recent work of Zondek on the hormonology of these tumors is of interest. Usually prolan A can be detected in the urine of these patients, prolan B is more rarely found. Zondek feels that the presence of a positive Aschheim-Zondek reaction is an index of the general body resistance, however, it may be absent in 40 per cent of cases. The author stresses the beneficial and often curative effects of roentgentherapy.

H. C. OCHSNER, M.D.

Myomas and Ovarian Tumors in the Roentgenogram. Günter K. F. Schultze. Röntgenpraxis, October, 1932, IV, 849-855.

Roentgenologic examination is certainly not indicated for the greater number of gynecological cases; in only a few exceptional ones is it indicated. A flat film is of value mainly in the case of encysted myomas and dermoids. A pneumoperitoneum or even the introduction of lipiodol in the peritoneal cavity is of little if any value. Demonstration of the uterus and tubes by means of injected lipiodol is an indirect means; changes in position of these organs gives an idea of the type of tumor present. Inflammatory tumors of the adnexa can be correctly diagnosed in over 90 per cent of the cases examined. The technique has to be most carefully followed. For the diagnosis of carcinomas of the uterus this method is not suitable. Clinically the diagnosis between myomas and ovarian tumors is occasionally impossible. In 128 such cases, in which the diagnosis was proven by operation, hysterosalpingography made possible a correct diagnosis in 84 per cent of the myoma cases, and 69 per cent in the ovarian tumor group. The roentgen signs of myomas are changes in the contour of the uterine cavity, increase in its capacity, and filling defects. Fluoroscopic observation during the injection of the lipiodol is essential in order that one may not miss temporary filling defects. The tubes are often not shown.

These cases were mostly clinically doubtful and not diagnosable. For the demonstration of ovarian tumors filling of the tubes is necessary as displacement of them and the uterus are the main symptoms. A film taken 24 hours after the injection of the contrast material is often of help. The lipiodol spreads over the surface of the tumor and can thus be directly seen.

H. W. HEFKE, M.D.

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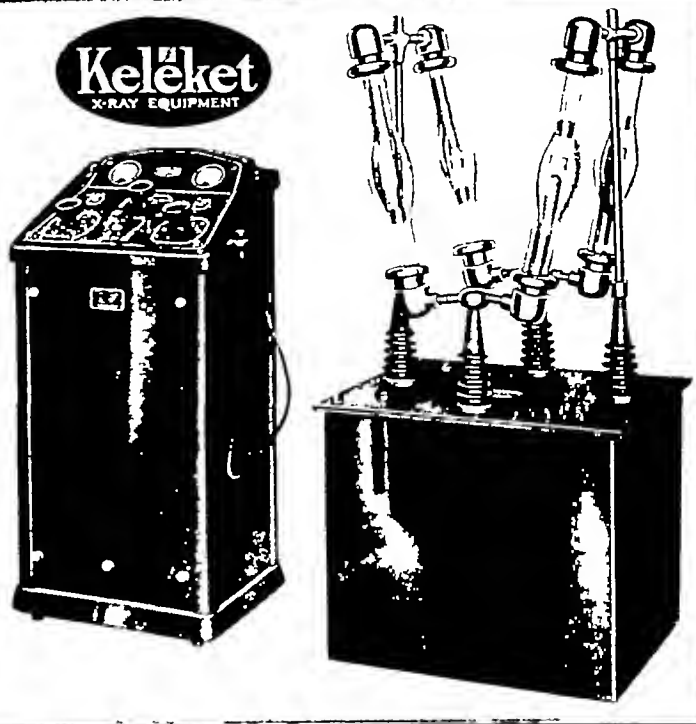
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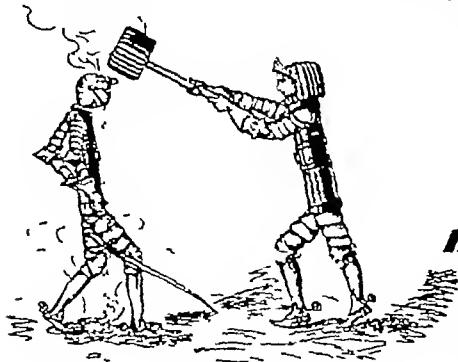
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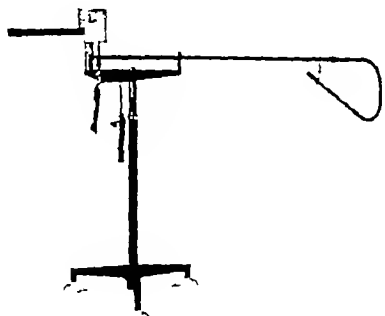


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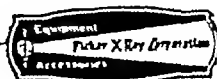
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AUGUST, 1933

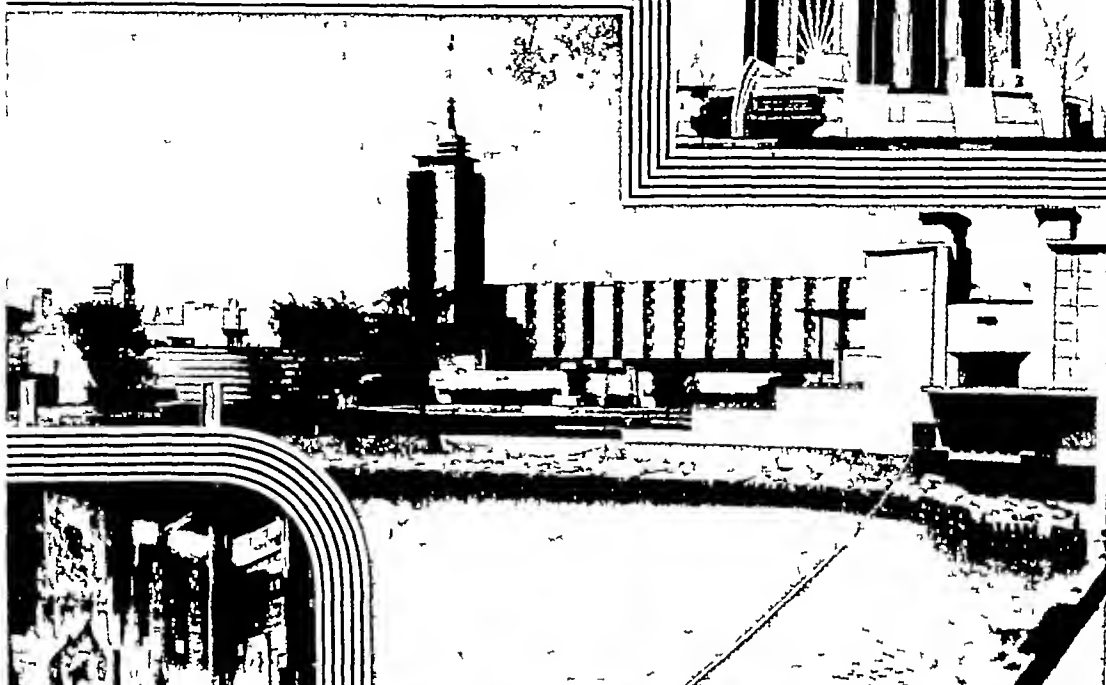
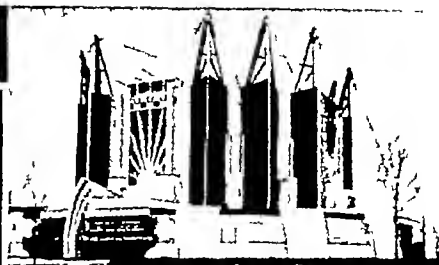
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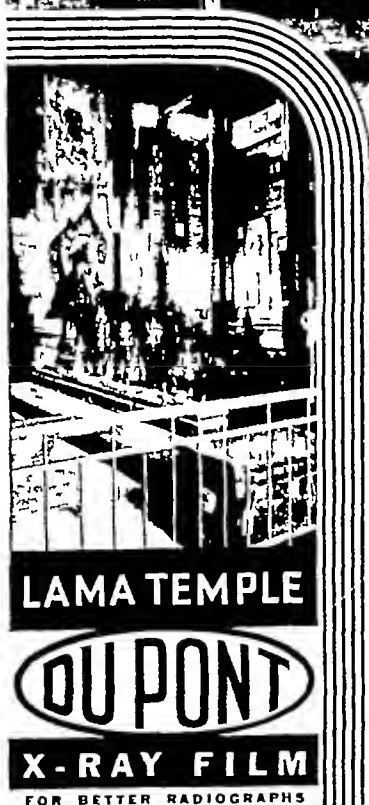
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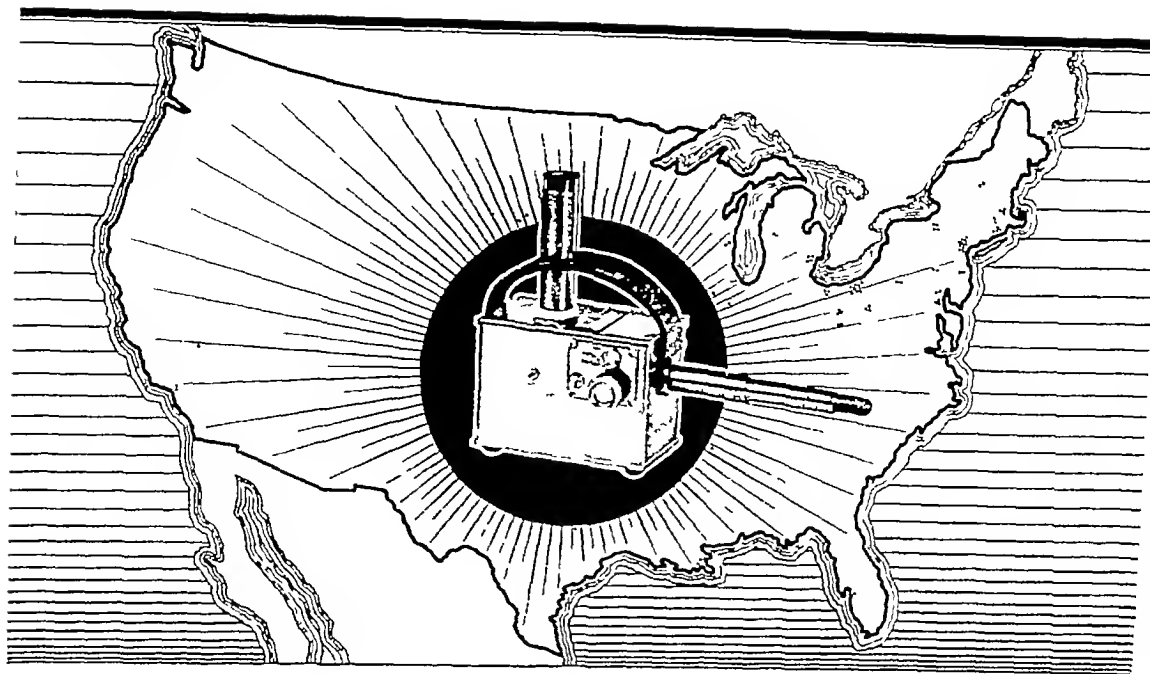
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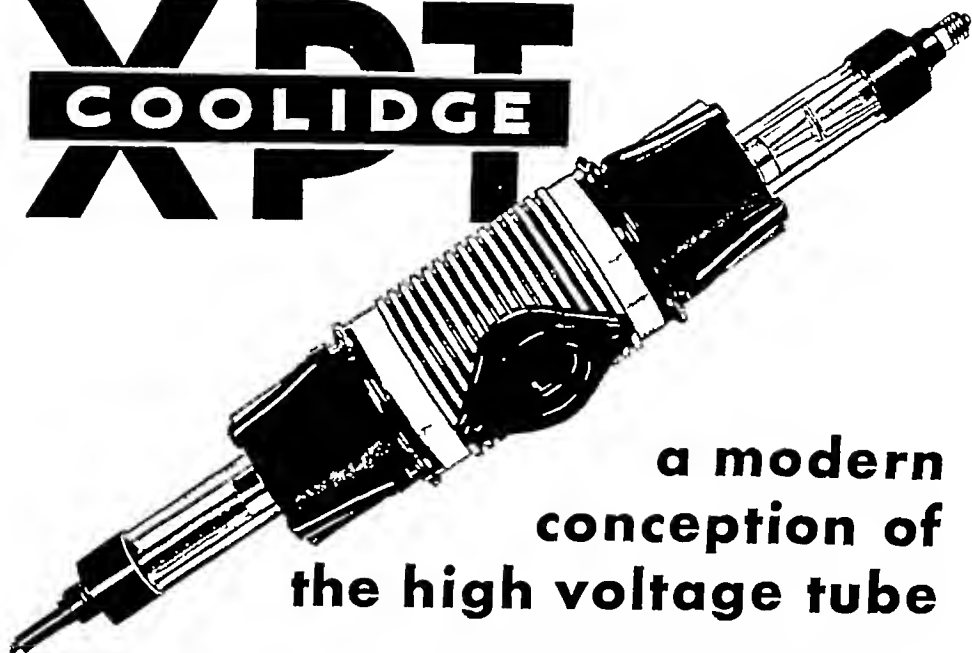
# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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VOL. XXI

AUGUST, 1933

No 2

## PULMONARY CHANGES FROM INHALATION OF NOXIOUS GASES<sup>1</sup>

By HOWARD P. DOUB, M.D., Department of Roentgenology, Henry Ford Hospital  
DETROIT, MICHIGAN

IN this day of widespread industrial development with its manifold activities, there is the constant danger that injuries and diseases may be produced if proper precautions are not carried out. One must ever be on the alert to recognize and classify the etiology of these conditions so that proper precautions may be taken to prevent them in the future.

It has long been known that the inhalation of nitric oxide fumes in proper concentration will produce serious symptoms or even death. The serious effects of the poison gases during the World War have also become a matter of general knowledge.

There is little in the literature to indicate that roentgen studies have been made on these cases. Major Callender (1), of the Medical Corps of the United States Army, states that he knows of no reports of roentgen studies of the lungs subjected to poison gases. Nichols (2) describes the clinical and roentgenologic effects of the inhalation of nitrogen dioxide derived from the decomposition of nitrocellulose films. He also gives suggestions as to the therapy. It was thought that due to the sparseness of the literature on the roentgenologic findings in

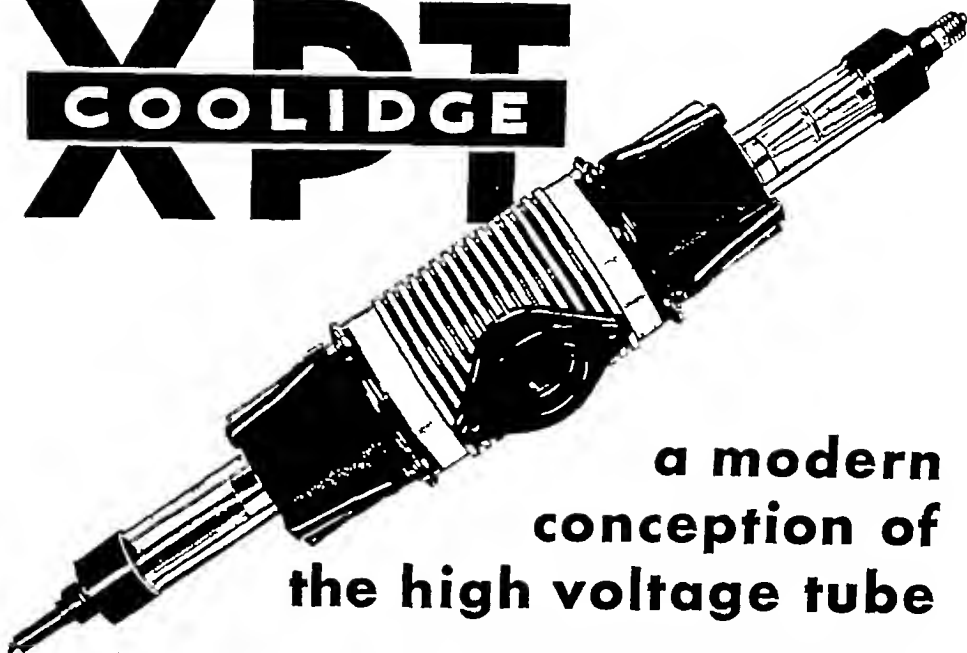
these cases, a short description, together with reports of several cases, would be in order.

### SYMPTOMS

The symptoms of inhalation of nitrogen tetroxide vapor have been described by Wood (3). If the vapor is not too concentrated there may be no symptoms at first, with the exception of a slight tendency to cough and an acid taste in the mouth. If a somewhat greater concentration of gas is present, those inhaling the gas become quite uncomfortable. Usually the sufferer recovers rapidly on exposure to the open air, but the symptoms are apt to recur with increased vigor six or eight hours later. If the vapors are concentrated there is often severe dyspnea and a feeling of pressure on the chest, coughing and cyanosis. These patients also may feel much improved on being taken into the open air, but usually, after a period of six or eight hours and sometimes while the patient is at complete rest there is a sudden attack of extreme dyspnea with pressure, resembling an acute attack of asthma. The patient is in evident difficulty, there is a cold sweat on the face and protrusion of the eyes. There are paroxysms of coughing which terminate in

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

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that, if there were concentrated blood and pulmonary edema, introduction of oxygen into the circulation did not prevent death

Nichols (2) discusses findings very similar to those found in war gas poisoning. The widespread pathology found at autopsy is shown by a case reported by him in which the following lesions were found: "Acute tracheobronchitis (slight), extensive pulmonary edema, widespread degeneration and necrosis, with regional thrombosis and hemorrhage, especially in the kidneys, lungs, myocardium, brain, esophagus, and duodenum, multiple infarcts in the lungs and kidneys, multiple areas of recent myomalacia, erosion of the duodenum and lower third of the esophagus, focal superficial necrosis of the mitral and tricuspid valves, with overlying fibrin thrombi, multiple areas of hemorrhage in the walls of the coronary arteries and regional tissues, hydrothorax amounting to 1,000 c c on the right side and 600 c c on the left, early bronchopneumonia, cardiac dilatation."

Similar reports of pathology were found among the reports of war gas poisoning.

#### ROENTGEN FINDINGS

Films of the chest during the acute stage revealed a diffuse generalized infiltration throughout both lungs, with a more or less even distribution in the nature of indefinitely outlined, confluent patches of increased density, suggesting a soft, exudative type of infiltration. There were some areas which suggested that they were due to patches of bronchopneumonia. Some of the changes were similar in appearance to those seen in the lungs secondary to cardiac decompensation.

The lung changes show a tendency to clear up rapidly in favorable cases, and definite improvement may be seen from day to day. In one of our cases there was complete clearing of the lung fields in eight days but in this case there was no evidence of any

fibrotic changes. In another case, evidence of considerable fibrosis was seen in the lung, but this was thought to be secondary to a concomitant tuberculous lesion, an explanation which was verified at the postmortem examination.

#### CASE REPORTS

Case 1 W F C, colored male, aged 33 years. Complaint: "Hard to get my breath."

The patient was well and free from complaint until two days previous to admission. At that time, he poured some sulphuric acid into a zinc pail and the room immediately filled with fumes which tended to suffocate him. He was removed to the emergency hospital in the factory and later sent home. Since that time there had been constant severe dyspnea. He denied any previous symptoms which would suggest bronchial asthma or cardiac disturbance.

Physical examination was negative, except for the chest. There was marked dyspnea, expiratory in type. Percussion was negative. The breath sounds were loud and whistling and there were some moist râles at the bases. The cardiac examination was negative. These findings suggested acute bronchitis and bronchial spasm from chemical irritation.

At this time, x-ray examination of the chest revealed a generalized mottling throughout both lungs, with dense areas of indefinite outline suggesting a diffuse bronchopneumonia of both lungs (Fig 1).

The patient improved, and on the eighth day was reported as being comfortable, having no pain, dyspnea, or fever. He was discharged to his home on the fourteenth day. After the seventh day, his temperature ran a normal course.

On the twenty-first day, he returned with a history of persistent cough and expectoration, with hemoptysis for three days. Temperature, 101, pulse, 128, white blood count, 20,000, polymorphonuclears, 84 per



vomiting, cyanosis is regularly present. The attack usually results in death within 48 hours, although there may be an interval of as long as two or three weeks. Death in these cases, which is usually caused by edema of the lungs, is most often preceded by the expectoration of a foamy, yellowish fluid and by evidence of cardiac failure. Those patients who have inhaled small amounts of the gas frequently go on with clinical findings of acute bronchitis and evidence of lobar or lobular pneumonia.

The use and effects of poison gases during the World War are described in Volume XIV of the series entitled "The Medical Department of the United States Army during the World War." Gilchrist (4) states that phosgene, diphosgene, chlorine, and chloropicrin are lung irritants. Nitrous fumes and mustard gas also have similar properties. The common reactions of these gases are the irritation and damage which they produce in the lower air passages. They cause an inflammatory exudation of fluid and may result in death by asphyxia.

The symptoms following inhalation of these gases were similar to those described above under nitrous tetroxide poisoning. In high concentration, they often produced suffocation, and they frequently killed almost instantly by respiratory paralysis. Usually, however, the concentration of the gas was such that the suffocative stage was passed safely. The patient usually felt fairly well during the next few hours but, on examination, his pulse and respiration were found to be accelerated and his temperature subnormal. Headache, substernal pain, cough, and constriction in the chest were complained of a little later. Pulmonary edema commonly occurred at this time. In milder cases bronchitis merely and not edema was present. In those cases in which the progress was unfavorable the respiration was high, the pulse grew more rapid and feeble, sonorous tracheal rales were present, bloody froth ex-

uded from the mouth, and death occurred generally in the second half of the first day. In uncomplicated cases there was usually improvement after 72 hours, and, at the end of a week, the patient was fully convalescent. One of the striking features in certain patients was the severe, or even fatal, symptoms induced by exercise. After mild exercise some cases with very mild symptoms suffered a complete collapse. Dyspnea and cyanosis were present and immediate treatment was necessary to prevent death itself. In cases which showed no improvement after 72 hours, bronchiopneumonia was generally found to be present, lobar pneumonia was more rarely found. No description of x-ray examination of the lungs could be found in this most excellent treatise.

#### PATHOLOGIC FINDINGS

Pappenheimer (5), in describing the pathology of war gas poisoning of the suffocant type, states that the body presented a dusky, livid hue. The lungs were bulky and did not collapse when the chest was opened. The pleural cavities contained considerable blood-tinged, serous fluid, and there was every evidence of marked pulmonary edema. The trachea and bronchial tree were filled with a foamy, pink fluid and the sectioned parenchyma exuded fluid and foam. There was often disruptive emphysema beneath the visceral pleura. The blood was quite dark and thick but coagulated normally.

The most difficult problem was to differentiate the lesions produced by the direct effect of the gas from those produced by the secondary infection of the respiratory tract.

Underhill (6) in experiments on the physiologic action of war gases came to the conclusion that death was not directly attributable to pulmonary edema but was due to increased blood concentration. He demonstrated that the restoration of the blood concentration to normal saved the animal even though the lungs were edematous and

cent, sputum examination, *Pneumococcus* Type IV

Physical examination at this time revealed early bronchopneumonia and possible miliary tuberculosis

X-ray films of the chest showed an extensive parenchymatous lesion extending from apices to bases of both lungs. Some of these changes suggested exudative lesions and others suggested fibrous lesions, while there was one small area of frank consolidation. The findings suggested aspiration bronchopneumonia, with possible tuberculosis (Fig 2)

Three days after admission, the patient developed alarming dyspnea, with marked cyanosis. There was moderate abdominal distention. He continued to decline and died on the fifth day after admission.

The autopsy was performed in the coroner's office and resulted in the following report: "Bronchial pneumonia and acute exudative miliary tuberculosis." No microscopic examination was done and no tissue was saved.

Case 2 R. C., colored, male, age 31 years. Complaint: coughing up blood and pain in the chest. The patient was well and "felt fine" until two days before admission, when he was transferred from his regular job to a room about five feet square. Here, in the course of his work, he dipped a soldering iron in hydrochloric acid and then into water. This process gave off clouds of irritating fumes. He had been at this work about ten minutes when he began coughing, about an hour later he coughed up some bright red blood. This continued and became worse so that, after five hours, he was forced to leave work. As his symptoms continued the following day he consulted a physician.

Physical examination on admission disclosed many coarse bubbling râles over both lungs. There were friction sounds in the left axilla. The clinical impression was acute bronchitis and bronchopneumonia.

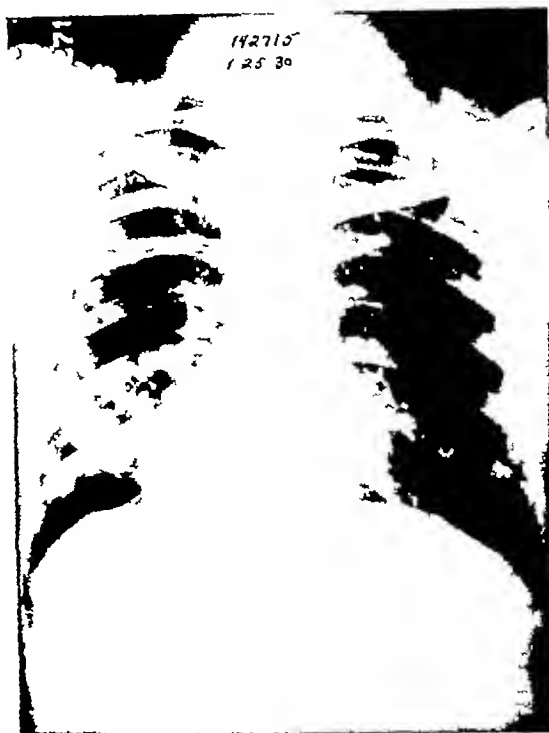


Fig 5 Case 2 One week later Lungs clear

Temperature, 101.4, pulse, 124, respirations, 32, Wassermann negative, blood cultures, persistently negative, sputum examination, *Pneumococcus* Type IV, white blood count, 18,750.

X-ray examination of the chest on admission revealed a dense, hazy mottling throughout both lungs, with areas suggesting consolidation, particularly in the left lung. There was no fluid in the pleural cavities. Because of our experience in the previous case, we were able to state that the pathology was probably on an inhalation basis (Fig 3). X-ray examination the following day showed some clearing of the field and disappearance of the hazy mottled shadows (Fig 4). Eight days after admission the lungs were shown to be entirely clear and essentially normal (Fig 5). At that time the patient was feeling well and had little cough. The temperature and pulse were normal. Several months later the patient continued to feel well.



Fig. 1 (upper left) Case 1. Mottling throughout the lungs. Fig. 2 (upper right) Case 1. Parenchymatous lesions in both lungs with marked increase in three weeks. Fig. 3 (lower left) Case 2. Extensive bronchopneumonia of both lungs, especially the left. Fig. 4 (lower right) Case 2. One day later. Some clearing in the left upper lobe.

oils and fats cause pneumonia when they are introduced into the bronchi Laughlen (9) calls attention to pneumonia following aspiration of mineral oil Thomas and Jewett (10) describe a case of pneumonia from cream aspirated from the esophagus in a case of cardiospasm X-ray examination showed a diffuse, hazy, finely mottled infiltration throughout the right lung, more marked in the middle third The left lung showed a similar infiltration in the base Zinc stearate has also been reported by many writers to produce pneumonia after being introduced into the lungs by insufflation This usually occurs in infants

It is apparent from all these studies that the pulmonary structures are much less resistant to irritants of various kinds than are the nasopharyngeal structures In the reports quoted above, and in our case reports, the common factor present is a lung irritant This varies in intensity according to the chemical composition of the irritant, but in most cases a heavy exposure to a lung irritant results in an ulcerative bronchitis or pneumonia with pulmonary edema In certain of the war gases, death is due primarily to suffocation, before the later irritative effects have time to take place

In the cases reported here, pneumonia was produced in the two cases exposed to acid fumes (Cases 1 and 2), and acute ulcerative bronchitis was the terminal finding in the case exposed to chlorine gas (Case 3) The x-ray findings in the lungs of the patients exposed to acid fumes were striking There was bilateral, evenly distributed parenchymatous involvement, with evidence of scattered areas of consolidation, and pulmonary edema One of these cleared up completely in eight days which would be unusual in pneumonia produced by infection On the other hand, two of these cases showed pneumococci in the sputum One case was complicated by acute miliary tuberculosis, but we are unable to say what part

the irritant played in its development Pathologically, it is difficult to differentiate the lung lesions produced by the direct effect of gas from those produced by the secondary infection

From the discussion above, it becomes evident that extreme care should be taken to safeguard workmen whose duty it is to handle various acids and substances which give off noxious fumes Nitric acid is especially dangerous, as nitrogen tetroxide is given off when the acid comes in contact with various substances We are all familiar with the fact that the decomposition products of nitrocellulose films are dangerous and that they can be avoided by the use of films with an acetate base The danger of chloride of lime and other similar substances is shown by the third case in which the patient was performing a simple household duty When they are handling any acids or substances which may, by chemical action, liberate dangerous fumes, workmen should never be confined in small, poorly ventilated rooms These precautions may seem like homely axioms, but every day men are working under similar conditions because this fact has not been sufficiently stressed

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Case 3 W A W, white, male, aged 53 years. The patient was admitted to the hospital in a delirious state. The history, obtained from other sources, was to the effect that, two weeks previous to admission, the patient was using chloride of lime in cleaning a sewer. Strong fumes were given off so that he coughed considerably. Two days later blisters began to develop on the face and other parts of the body. These broke and considerable skin about them was exfoliated. The patient had been toxic, but had had no treatment at home.

The physical examination disclosed many moist râles over both lungs. Percussion was negative. There were many areas over the body showing exfoliation of the skin. Temperature, 103, pulse, 148, respirations, 33, blood pressure, 90/65, non-protein nitrogen, 75.

The patient declined rapidly, dying 24 hours later without regaining normal consciousness at any time. Roentgen examination of the chest was not carried out. The clinical diagnosis was chlorine gas poisoning.

Postmortem examination revealed extensive excoriation of the skin, acute stomatitis, acute ulcerative bronchitis, empyema of the lungs, acute nephritis, and cloudy swelling of the liver. These were all attributed to chlorine gas poisoning. In addition there was evidence of lymphosarcomatosis with metastasis to the spleen.

#### DISCUSSION

It was mentioned in the opening paragraphs that records of roentgen studies of the lungs of patients suffering from inhalation pneumonia are infrequent in the literature. The symptomatology and pathology, however, are adequately described.

In the case described by Wood (3) death resulted from the inhalation of nitric oxide fumes. Autopsy disclosed bronchiopneumonia chiefly in the lower lobes. There was

desquamation of the mucous membrane of the trachea and bronchi over extensive areas. Cellular plugs were found in some of the bronchi, and areas of consolidation around the smaller bronchi. The alveoli were filled with a transparent albuminous mass—fibrin containing a few leukocytes, or with desquamated alveolar epithelium. No evidence of any organisms was found. In a series of experimental animals in which pneumonia was produced by inhalation of nitrogen tetroxide, these were found to be sterile pneumonias. Wood believes that the great danger of nitrogen tetroxide lies in the fact that weak mixtures of the gas with air can be inhaled without producing spasm of the larynx, so that the lungs are seriously damaged before severe symptoms are present. Chlorine, sulphur dioxide, and ammonia, on the other hand, are likely to cause spasm of the glottis, with resulting suffocation.

Wollstein and Meltzer (7) produced a chemical pneumonia by injecting chloramine-T solution into the lungs of dogs, thus producing bronchopneumonia in 24 hours which cleared up gradually during the following week. There was no fever or other appearance of illness in the dogs. The pneumonia was sterile.

Koontz and Allen (8) studied the relationship of bacteria to chemical pneumonia, but came to no definite conclusion as to whether or not bacteria occupied a causal relationship to the pneumonia found in gassed lungs. They found bacteria (not intracellular) present in many lungs but they were not present in large numbers in the majority of cases.

The interesting feature in all these cases is that, while from an anatomic standpoint these chemical or irritative pneumonias are similar to the infectious pneumonias, they differ in that they are sterile and may manifest few symptoms.

It is also a well known fact that various

infected tonsils Cardiac tonics were given also

The man's nasal obstruction has been largely overcome His pulse rate is now normal He has gained some weight but yet he is not able to work in acid fumes, as he then develops asthma again

What may be expected as to the permanent cure or relief of this man? The industrial question also comes up How much compensation is he entitled to?

DR DOUB (closing) In regard to Dr Christensen's case, it is a difficult matter, of course, to discuss compensation because it is problematical as to how much of the damage is due to gas and how much to other contributing causes Unless we study serial films and all the other factors in the case, I do not believe one can say much about it

One of our patients entirely recovered I have records of him six months later and at that time he was still completely well It seems to me that, if it is a mild case, it will clear up with complete restoration of the normal lung If, however, it is sufficiently severe to destroy the mucous lining of the bronchi, it will be followed by fibrosis, which will not disappear We have all seen cases of soldiers who claim to have been gassed during the War and who complained a great deal of their condition, but, roentgenologically, the only change seen was fibrosis in the lungs Whether or not the fibrosis was due to gas, I am not pre-

pared to say, as it is always difficult to establish that point

In general, I will say that the cases we had were both similar to Dr Christensen's They were both working in the radiator departments of automobile factories, and they both had a similar type of exposure to the gas The exposure occurred while they were using a soldering compound I am not absolutely sure whether or not both of them were exposed to hydrochloric acid The history indicated that it was hydrochloric acid in one case and sulphuric in the other I am a little inclined to think they were both using hydrochloric acid, but I cannot verify it

The general consideration that we are interested in is the type of response of the lung to an irritant The response is not remarkably different to that from other lung irritants We know that aspiration of oils into the lungs is dangerous, a great many persons feel that the introduction of lipiodol into the lungs is not without some danger This, however, would seem to be somewhat minimized by the amount that is used and the relatively few bad results that have been reported

Thomas and Jewett have reported a case of pneumonia following aspiration of cream Various other pathologists have reported similar cases from aspiration of other oils Dr Wood has ably described the pathologic response of the lung to the irritation This, however, does not depend on any specific irritant

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#### DISCUSSION

DR F C WOOD (New York City) Dr Doub's paper has been most interesting, especially in connection with several recent film fires. My interest in the matter arose from a study of a case of nitric oxide poisoning (3), for among other substances which are present in the fumes of burning films is nitric oxide. My studies were chiefly on the morphology of the terminal lesion in the lung, which was a bronchopneumonia, accompanied by filling of the alveoli with desquamated epithelium. Since that paper was published, many similar observations have been made, based upon the use of irritating gases during the War.

The lesions all possess a certain similarity. The problem is an important one, because the destructive process leaves permanent changes in the lung. In some infectious diseases also, a similar lesion is occasionally found. The question has been raised as to whether or not the increased frequency of cancer of the lung, observed of late, may not follow upon such a chronic pneumonia. The introduction of slow-burning films helps the situation, but we still have the same industrial risks in the huge chemical factories which have developed in this country since the War.

Dr Doub's contribution, therefore, is important as calling attention to the subject and describing the conditions which exist in so clear and effective a manner.

DR F C CHRISTENSEN (Racine, Wis) I have a case under my care of a man who was totally incapacitated because of acid fumes. He was a tool and die maker, working in the experimental department of a radiator factory. They were trying to solder the radiators *en masse* rather than have individual men work on them. Part of the radiator came in through a vat of hydrochloric acid, and then was transferred into a vat of hot solder. Naturally all the acid that was on the radiator portion to be soldered evaporated from the

heat, thereby producing emanation of hydrochloric acid fumes.

The man was working in a small, poorly ventilated room. After working there for several months, he developed a decompensated heart. This experimental room was on the fourth floor of the factory and the tool room was on the first floor. He was compelled to make numerous trips to the tool room, and to walk back up to the experimental room. He made from 15 to 20 trips a day walking four stories.

When I saw him he had not been able to work for several months. He had lost considerable weight. He had severe asthma, with marked emphysema of the lungs and a marked dilatation of the heart. The basal metabolism was normal. There was no toxic thyroid condition. His blood picture was rather interesting—lymphocytes were 63 per cent. All his teeth had been removed in an attempt to remedy his condition, before I saw him. He did have, however, a pair of badly infected tonsils. There was complete nasal obstruction.

As I looked up the literature, I found that there was not a great deal written on hydrochloric and sulphuric acid fumes. I did find however that the Consumers' League of Massachusetts called attention to one factory in which they were watching individuals who used these acids, and the susceptible individuals were being transferred to other departments. Dr W A Brann, of London, has called attention to the fact that heavy materials and acid fumes produce catarrh of the respiratory tracts, with emphysema and heart failure. The "Industrial Hygiene Bulletin of New York" reported by Dr Jermian states that sulphuric acid fumes and hydrochloric acid fumes are common causes of respiratory pathology. Haggard in a publication of Yale University calls attention to the fact that hydrochloric and sulphuric acid fumes are rapidly absorbed by the upper respiratory tract. Because these fumes are highly soluble and the ordinary tinmer has to deal with rather small quantities there is rarely any effect in the deep respiratory organs of such workers.

In this case the treatment was epiphren to nasal mucosal membrane and removal of the

tensity of the local irradiation reaction by a very great deal. They remain, in the author's judgment, the most desirable form of implant. If implanted directly through the hypopharynx, however, they are open to the

the accuracy possible when the part to be avoided (cartilage) is readily palpable.

More or less concurrent with the filtered radon work,  $\lambda$ -radiation has come to be much more efficient technically and more in-



Fig 1 Case 1 (left) Lateral view showing mass overhanging larynx

Fig 2 Case 1 (right) Lateral view showing radon seeds in relative position

same objection from the infection standpoint as the old original unfiltered glass implants—minus, of course, that phase which was intensified by virtue of the beta and soft gamma radiation of the latter.

Element needles or radon implants introduced through the hypopharynx by either direct or indirect vision are rarely placed with the accuracy which the operator would like to accord himself. Such work usually lacks the advantage of stereoscopic vision. It is easy to insert a needle a centimeter or more beyond the point where it is thought to be placed. If, as is more frequent than not, the implantation is at a tangent to the basal plane of growth infiltration, the danger of misplacement is increased. In the average case more implants must be inserted through ulcerating infected tumor tissue than through intact mucosa around it. The relative position of implant to cartilage is a matter of conjecture, it is not placed with

telligently applied. Voltage, filter, and skin-target distance have increased. Dosage has been fractionated to the advantage of both the local and constitutional reaction. Measurement of the individual dose is accurate and it can be duplicated. The initial skin erythema does not assume such prominence in  $\lambda$ -ray therapy as it once did, consequently, the total dose has steadily increased.

The hypopharynx is a favorable area for  $\lambda$ -radiation and hypopharyngeal growths, as a group, are as radiosensitive as any group of epidermoid carcinomas and more so than most. The effort has, therefore, been made to care for as many of these growths as possible by external irradiation, many of them being sufficiently radiosensitive to permit of this and within the limits of reasonable skin and soft-part reactions.

In some clinics, notably that of Coutard, of Paris, the method is extended to and intensified in an effort to care for all carci-



## RADIUM IMPLANTATION IN CERTAIN GROWTHS OF THE HYPOPHARYNX<sup>1</sup>

B<sub>2</sub> DOUGLAS QUICK, M B (Tor), F A C S, NEW YORK CITY

**M**ALIGNANT growths of the hypopharynx present an unusual number of difficult therapeutic problems. Practically all being surgically inoperable, radiation therapy in some form becomes, of necessity, the only means of treatment. While most growths in this location fall within the general group of epidermoid carcinomas, they nevertheless vary widely in histologic structure, a fact which calls for considerable variation in the method and intensity of irradiation therapy for the individual case. Fortunately they are as a group rather more radiosensitive than growths of similar histology in the oral cavity. In spite of this, the hypopharynx offers its own peculiar set of complicating factors.

Hypopharyngeal growths are at best technically difficult of access. Close observation in some patients is difficult and trying, consequently, there is interference with proper cleansing during treatment procedures. Satisfactory and complete palpation is usually impossible—and palpation is frequently of greater value than direct visualization in determining the actual extent of an infiltrating growth. On account of the location the processes of swallowing and breathing may be embarrassed, the former is usually hampered to some extent and often seriously. Breathing may be obstructed to the point of tracheotomy, while any ulcerating lesion in the hypopharynx increases the hazard of aspiration infection of the bronchial tree. For these reasons alone it is most important that swelling and local infection be avoided insofar as possible.

If the cartilages of the hypopharynx become infected or if infected material be

transferred to depth in and about the tumor-bearing area, the inflammatory phase is not only intensified but prolonged. If the cartilages be unduly damaged by irradiation, this inflammatory phase is still further prolonged and intensified.

Even though, under such conditions, primary healing without necrosis is obtained, the danger of secondary necrosis is much greater on account of the low grade infection remaining temporarily quiescent at depth in the tissues which have healed on the surface. In most instances retained infection is the inciting cause of secondary necrosis. The normal favorable reaction of tumor tissue to irradiation in any form is always discounted by infection.

In the early days of irradiation therapy when relative intensities were not as fully appreciated as now and when x-radiation was far less efficient, the hypopharyngeal growths were approached directly with radium in some form. Radium element needles had a limited sphere of application—apart from all other technical considerations it was impossible in the majority of instances to keep them in place for adequate and accurate dosage. Unfiltered radon seeds by direct implantation at that time gave better results. The local reactions, however, were most severe. Due to the beta and soft gamma radiation necrosis was the rule rather than the exception. This method of introduction and its resulting reaction created all of the conditions enumerated as undesirable from an idealistic standpoint. The one point in favor of the method was that it afforded a means of delivering to the tumor-bearing area an intensity of irradiation sufficient to destroy the growth.

During the past few years filtered radon seeds (0.3 mm gold) have reduced the in-

<sup>1</sup>Presented before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City, Nov. 29-Dec. 1, 1932.

tensity of the local irradiation reaction by a very great deal. They remain, in the author's judgment, the most desirable form of implant. If implanted directly through the hypopharynx, however, they are open to the

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In some clinics, notably that of Coutard, of Paris, the method is extended to and intensified in an effort to care for all carci-



Fig 3 Case 1 Schematic drawing to show location of growth in three positions (A) postero-anterior, (B) lateral, (C) anteroposterior

nomas of the hypopharynx by external irradiation. Such work is extremely interesting and valuable—it should be observed and carried out with an open mind. Certain questions of doubt as to the extent of its applicability must of necessity arise, since it calls for a rather nice decision between that which is tolerable and that which is intolerable on behalf of the patient.

Anyone who has treated a series of these cases by the large fixed total dose must have been impressed by certain features and shocked by others. The variation in response between individuals with as nearly as possible comparable growth histologically, is pronounced. Some tumors in the upper ranges of dosage intensity seem to have regressed completely and a few months later

break down again or increase in bulk, showing thereby that surface healing was deceptive. With the maximum intensities of dosage, the raw skin of the neck, the marked dryness of the throat from inhibited mucus secretion and altered salivary secretion with its resultant adverse influence on local infection, cannot be ignored. The marked nutritional disturbances, the pronounced generalized inflammatory reactions in the throat (usually requiring post-nasal-tube feeding and frequently trichotomy) call for serious consideration. The autopsy findings in many of these cases are strongly suggestive of the unfiltered radon reactions of several years ago. It is humiliating to have a patient come to autopsy free from tumor.

It is probable that certain classes of in-

dividuals tolerate and accept such reactions better than others. It is even possible that, with certain levels of our present-day social strata, it is best to accomplish as much as possible by external irradiation and there rest. It is questionable, however, if a method which produces such intense reactions should be applied to all carcinomas in a given anatomical group, also, whether such reactions will be ultimately acceptable either within or without the medical profession. We are all agreed that a substantial percentage of hypopharyngeal carcinomas respond completely to external irradiation alone and of such intensity as to be generally accepted as reasonable in its reaction upon the patient.

With this short review of the work to date as a background, the writer offers a suggestion which, so far, has given promise of substantial aid with the more radioresistant growths in this anatomical zone. It should be regarded as a suggestion or a preliminary report rather than as ultimately proven work. Its application is limited to that group of cases which respond slowly to external irradiation as the individual exposures accumulate, thereby suggesting that healing will be but transient or frankly incomplete within the limits of total dosage which fall short of superficial destruction of skin.

It is an effort to combine  $\gamma$ -radiation within reasonable limits with the conservative aid of filtered radon seeds (0.3 mm gold) or needles containing either element or radon. The disadvantage of these implants, as previously indicated, in whichever form applied, lies in introduction through the oral cavity and hypopharynx. To obviate these disadvantages a means must be found to introduce the implants in clean surgical fashion and accurately in relation to the infiltrating base of the growth. The cartilages must be sufficiently avoided to prevent necrosis. The method must be a simple one in order that it may be acceptable to and reasonable for the patient.

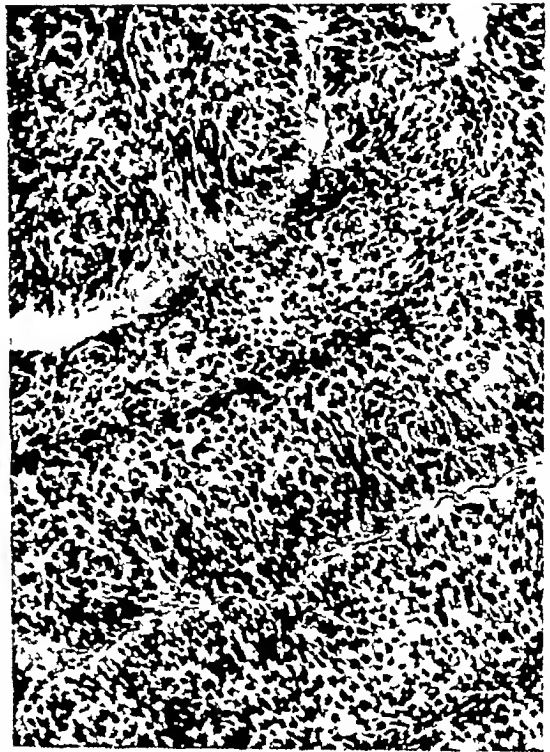


Fig 4 Case 1 Photomicrograph of tissue from epidermoid carcinoma, Grade II

A study of the anatomy of the hypopharynx by dissection and with the aid of plane and cross-sectional anatomical charts will show that the major portion, and frequently all of the base, of the usual hypopharyngeal growth lies opposite a well-defined anatomical zone. This zone extends from the midline backward to the carotid sheath and from the superior border of the lateral ala of the thyroid cartilage upward to the hyoid bone. If the growth extends below this zone, it is intralaryngeal. If above it, it is still accessible from the neck side, with the hyoid bone serving as a guide.

In the group of cases which have been done the external irradiation was carried up to the point of maximum erythema, short of skin destruction. The reduced growth was then studied accurately, by both indirect and direct laryngoscopic examination, in order to localize it relative to the cartilages and



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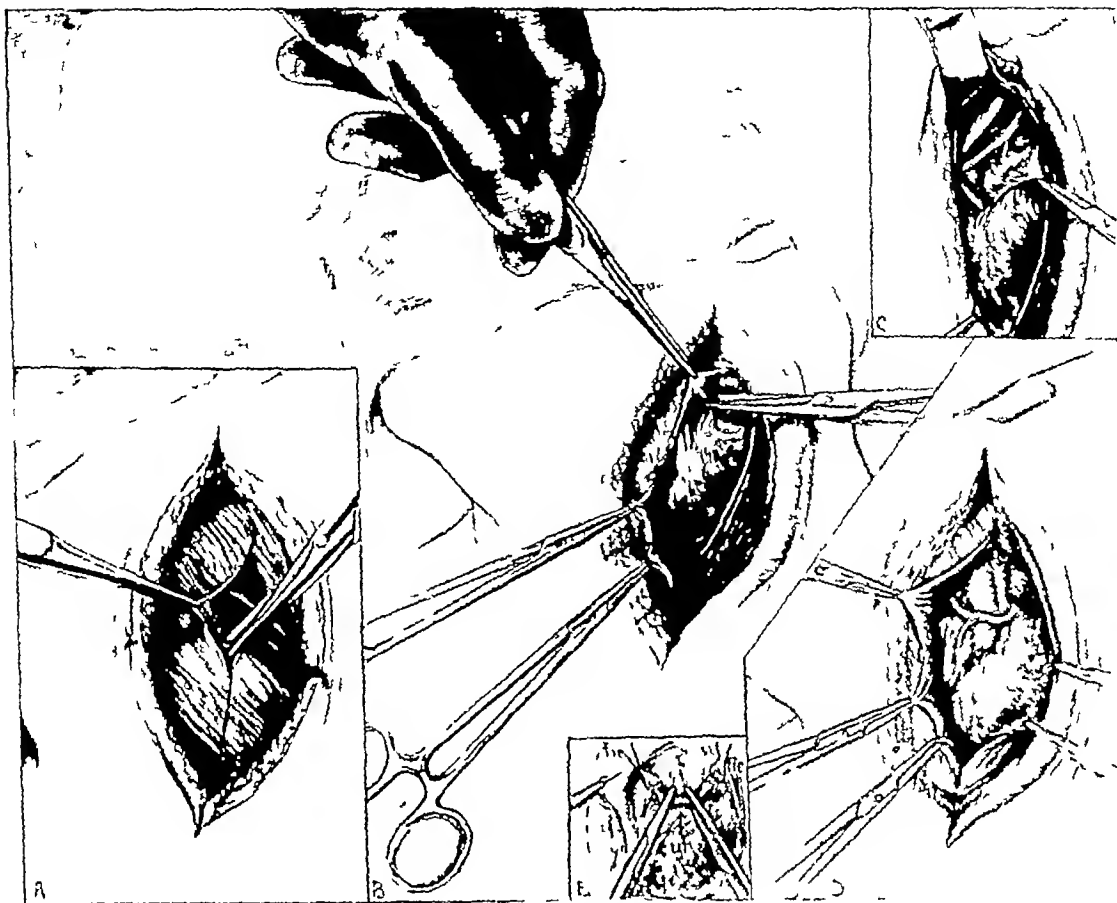


Fig 7 Case 3 Actual drawing made at the time of operation showing surgical procedure in stages (A) Division of platysma parallel with anterior border of sternocleidomastoid (B) Reflection of platysma (C) Posterior digastric belly and hypoglossal nerve exposed (D) Metastatic node exposed sufficiently for implantation (E) Division of external jugular vein

carried out through a clean surgical wound, infection is entirely avoided. When the implantation has been completed the wound is closed and a small rubber tissue drain placed in its lower angle. If needles have been used, the threads are carried out with the drain for withdrawal of the needles at the proper time.

The accompanying drawings will serve to illustrate the procedure in both the presence and absence of a complicating metastatic node, in unilateral and bilateral external approach, and in the use of both 0.3 mm gold radon implants and 0.5 mm platinum needles.

The following two case reports accompany the drawings and may serve to give a clearer understanding of the sequence and intensity of treatment.

Case 1 J. D., male, age 55 years. Symptoms of hoarseness and dysphagia, two to three months' duration. Loss of 10 pounds in weight. Tumor mass arising in and apparently filling the left pyriform sinus of the larynx, semi-pedunculated and overhanging the aperture of the larynx so that the cords and arytenoids were obscured to indirect examination. Dimensions,  $2\frac{1}{2} \times 3\frac{1}{2}$  centimeters. By direct laryngoscopic examination the interior of the larynx was seen not to

hyoid bone. Following this, the zone just described in the neck was exposed under local anesthesia and through a 10-centimeter anterior sternomastoid incision. As the skin and platysma are retracted the anatomical

carotid artery may be ligated (if deemed advisable) in certain cases. If both sides of the hypopharynx are involved by primary growth, the external approach may be bilateral. With the appropriate exposure thus



Fig 5 Case 2 (left) Lateral view showing distribution of platinum needles on right side over base of primary growth. Radon seeds show through from the left side of metastatic node.

Fig 6 Case 2 (right) Anteroposterior view showing radon seeds in metastatic node and platinum needles over the primary growth site from the opposite side.

landmarks referred to come into view or are readily palpated. A limited dissection along the anterior sternocleidomastoid border brings the structures of the carotid sheath into view. The dissection at no point interferes with important blood supply. All vital structures are safeguarded by direct vision. If a metastatic node complicates the case, it can be implanted at the same time. In fact, if the most frequent node involved in these cases—that adjacent to the carotid bulb—is enlarged, it serves as an additional holder and filter for implants, not only for its own treatment but for irradiation of the primary growth as well. If the primary growth extends upward into the base of the tongue or the lower pole of the tonsil, the external

made it is a simple matter to insert into or beneath the infiltrating base of the primary growth a sufficient dose of gamma radiation to care for it, in either filtered seeds or needles. The implants are thus placed accurately and are properly spaced under direct vision. The cartilages are palpable and hence not only serve as landmarks but are avoided in making the implantation. If the implantation needs to be carried well backward, the carotid vessels may be retracted and the implant placed deep to the plane of the vessels. Similarly, if the growth extends well upward, implants may be placed near to or above the hyoid bone without damaging either the hypoglossal nerve or the submaxillary salivary gland. Since the procedure is

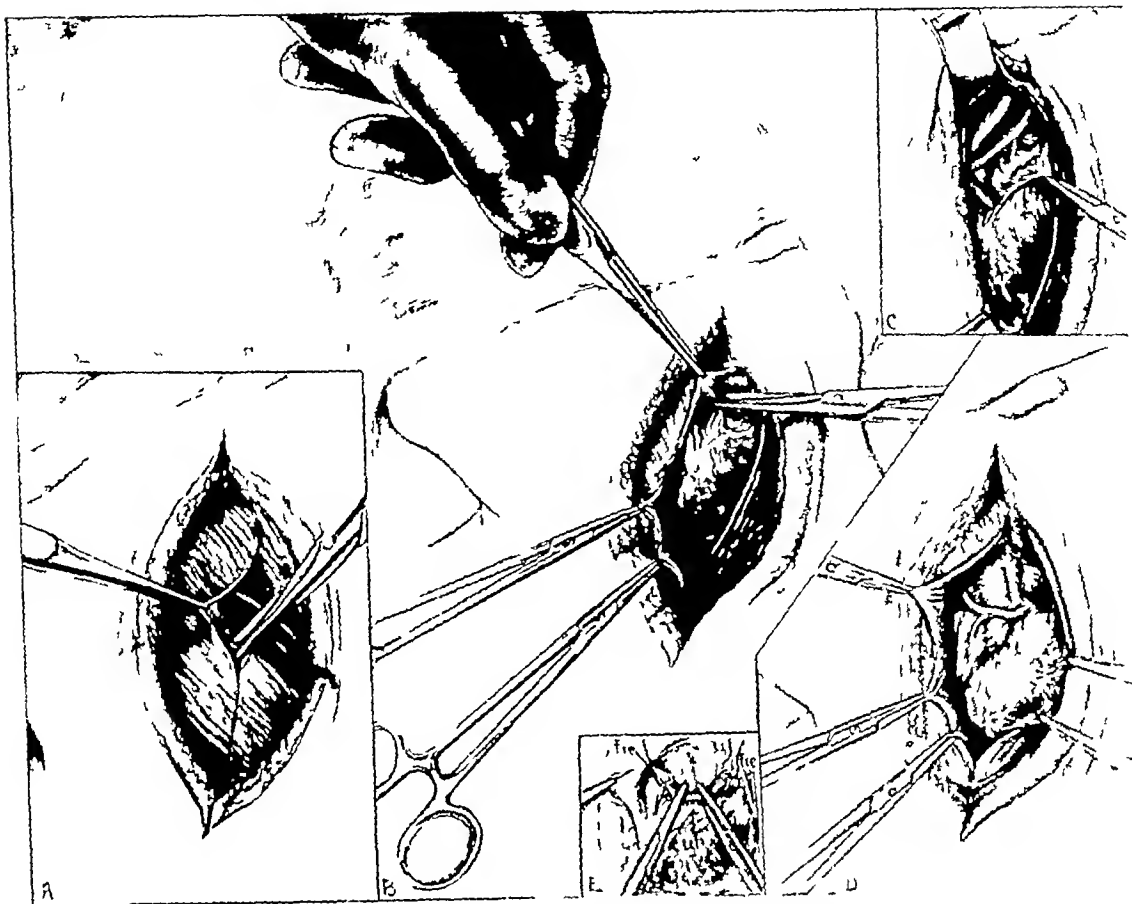


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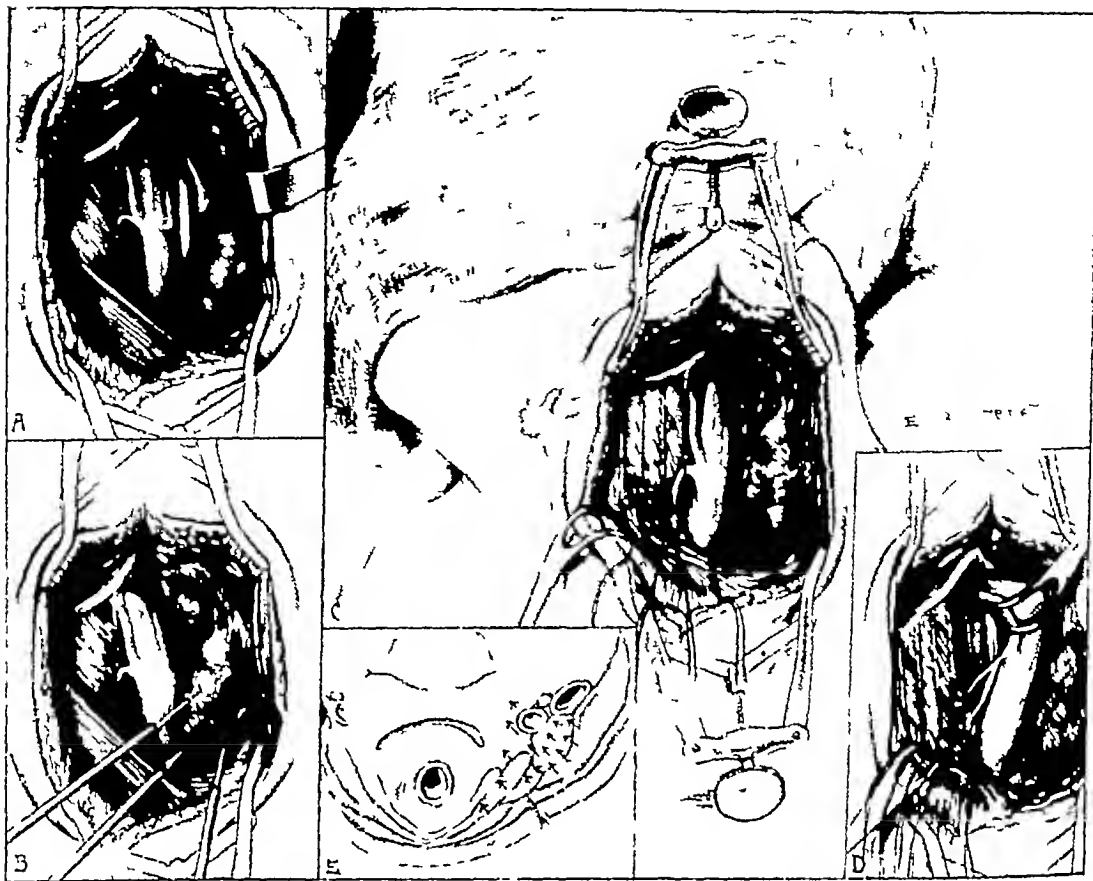


Fig 8 Case 2 Continuation of surgical drawing, Fig 7 (A) Carotid bulb exposed—jugular vein, sternocleidomastoid muscle and metastatic node retracted posteriorly. Vagus nerve is shown when the vein is retracted (B) Implantation of metastatic node with radon seeds (C) Implantation of platinum needles over base of the primary growth (D) Placement of 1st needle posteriorly by retraction of the carotid bulb. The needle lies deep into it and well away from the vagus nerve (E) Schematic drawing of needles and seeds in cross-section

be involved. No nodes were palpable in the neck.

**Histology**—Papillary transitional cell carcinoma showing slight anaplastic tendencies (squamous features), Grade 2. Films of the larynx in two planes showed a rounded mass in the region of the pyriform sinus extending above the larynx, with some apparent compression of the upper end of the esophagus.

**Treatment**—High voltage x-radiation 6 cm circular field 200 KV, 0.75 mm Cu plus 0.1 mm Al filter 50 cm distance in-

dividual exposures 400 r, total doses 2,400 r to each side of the neck within one month. Symptomatic improvement but very slight change in the size of the tumor. Unilateral surgical exposure through left neck immediately. Soft nodes presumably uninvolved found posterior to the carotid bulb. Gold radon implants 8 in number 2 mc each inserted in base of growth and 7 implants 2 mc each inserted in soft nodes posterior to the carotid bulb. Healing uncomplicated. No aggravation to swallowing very moderate. No interference with breathing. No tissue necrosis. Regression complete. Pyriform sinus



Fig 9 Case 2 Schematic drawing to show location of the primary growth in three positions and metastatic node in two planes and in relative relationship to the primary growth (A) postero-anterior, (B) antero-posterior, (C) lateral

normal, and weight normal at end of twelfth week

Case 2 I W, male, age 58 years Symptoms of eleven months' duration consisted of soreness in throat, intensified on swallowing, progressive, slight loss in weight, marked loss in strength The patient had found a larger shirt collar to be necessary for three months A tumor mass, extensively ulcerated and apparently beginning on the right base of the tongue, involved the epiglottis and extended to the left base of the tongue On the right side it circled about the wall of the hypopharynx, encroaching posteriorly on the esophageal entrance and the adjacent arytenoid In the lower left neck there was one metastatic node  $3 \times 4$  centimeters

*Histology* — Incompletely differentiated epidermoid carcinoma, Grade 2

*Treatment* — High voltage x-radiation, factors as for Case 1, except 10 cm circular field, individual exposures 400 r, total dose 1,600 r to each side of the neck, with 10-cm circular field, plus 400 r to each side, with 6-cm circular field, within a period of 24 days Regression partial Six days later surgical exposure was done to the left neck, a 15-cm incision Gold seeds, 10 in number, 2 mc each, were implanted in the metastatic node Platinum needles, 0.5 mm wall thickness and 26 mm length, 5 in number, 10 mc. each, were inserted parallel with vessels and with each other in muscular tissue between the thyroid cartilage and the hyoid bone The posterior needle was placed be-



# THE ADVANTAGES AND DISADVANTAGES OF LARGE CHAMBER MEASURING APPARATUS<sup>1</sup>

By ALBERT K. MERCHANT, M D PHILADELPHIA

ANY ionization chamber larger than 2 or 3 cubic centimeters in volume is too large for use in a phantom or for the determination of radiation intensity upon the patient's skin. For the purposes of this paper, any chamber of volume greater than 3 cubic centimeters is considered a "large" chamber. However, the actual volumes of

or (3) of organic material, or a special material and construction such as will insure the ionization current being constantly related to the "primary standard" readings

As advantages of the "large" chamber may be listed the following

1 The ionization current can be large enough to allow of use of a relatively

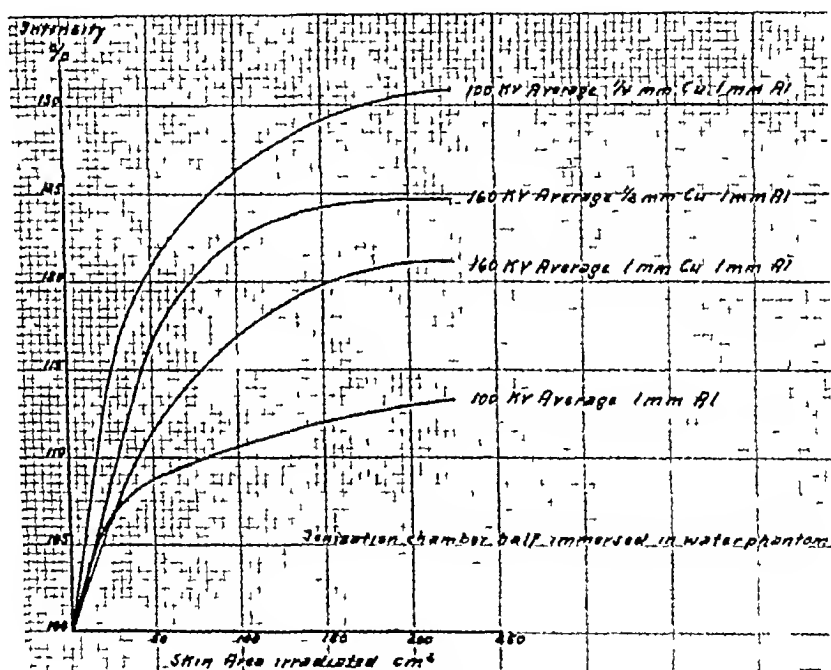


Fig 1 Ionization chamber at surface of cylindrical phantom, diameter 14 cm, length 25 cm built to imitate neck or limb

ionized air in the "large" chambers with which we have had experience have been from 20 to 300 cubic centimeters

Large ionization chambers may be (1) of metal construction, suitable for permanent mounting in the filter position, (2) of the all-air type, suitable for direct determination of the  $r$  (so-called "primary standard"),

rugged "micro-ammeter" for measuring the current

2 Even when not designed for use with a micro-ammeter, current may be measured with a galvanometer instead of an electro-scope. The special advantage of this is the ease with which one can avoid leakages and field distortions, because the galvanometer plate and lead are within a fraction of a volt of the guard ring potential

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis Nov 30-Dec 4 1931

3 With suitable construction and precautions, a "large" chamber may be built so that it will measure the x-ray beam directly in r per minute (a so-called "primary standard")

small ionization chamber alone, provided all readings are taken in the beam without scatter-back and are then carefully modified by proven factors based upon the quality of radiation, skin-target distance, and size of

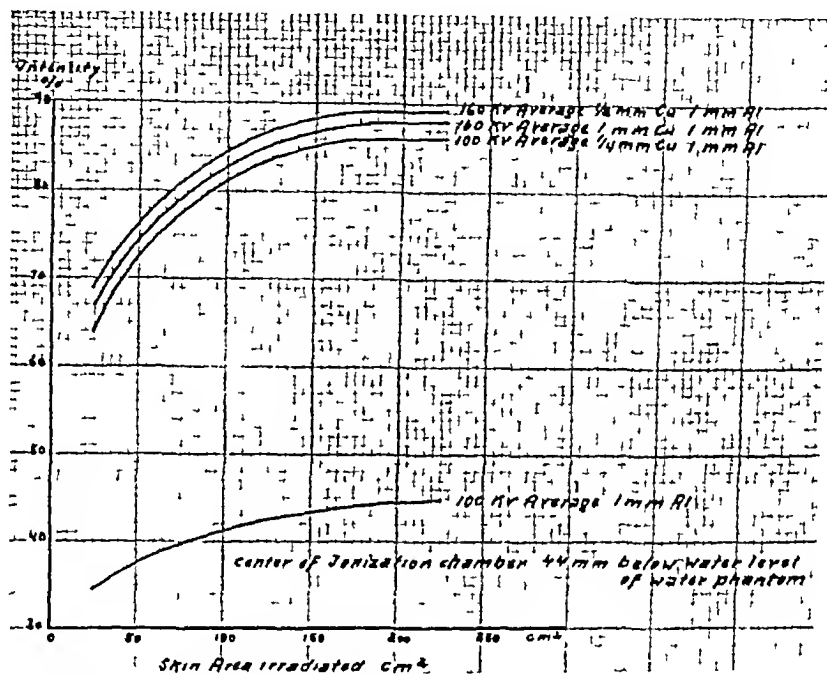


Fig 2 Ionization chamber at 44 mm depth near center of phantom used for Figure 1

Lack of portability is one of the disadvantages of the "large" chamber and this is not merely because of the large size of the chamber itself but because the charged plate or plates must be supplied with fairly large currents at high voltages, necessitating either large and heavy dry cells or "B-battery eliminator." The principal disadvantage of the large chamber is the impossibility of using it on the patient's skin or incorporating it in a phantom. Therefore it can be used only for determination of intensity in the free beam (without scatter-back).

In spite of the disadvantages just enumerated the large ionization chamber may be used successfully and with a higher degree of accuracy than can be obtained with the

field. Such factors have been supplied to us by the work of Dessauer, Holthusen, Trskine, Failla and Qumby, and others. It is an unfortunate fact that no two of these are in perfect agreement. This lack of agreement is probably incurable because of certain defects inherent in the small ionization chambers which have been used with phantoms and on the patient's skin.

We recently became interested in obtaining similar correction factors suitable for use in connection with radiation to the neck. For this purpose we used a bakelite cylinder 11 cm in diameter and 25 cm long filled with water. The small ionization chamber of a Victoreen r meter was half immersed in the water and readings were made with

changes in quality of radiation and in size of field. A similar set of readings was made with the ionization chamber in the middle of the phantom, 44 mm below the surface of the water. In making these measurements a metalix therapy tube was used, energized by a valve tube "constant potential" installation, with a 10 per cent voltage ripple. Figure 1 shows graphically the results of measurements with the chamber at the surface, half immersed, and Figure 2 with the chamber immersed, 44 mm below the surface of the water, near the center of the phantom.

We would like to call attention to the need for biological data on this subject of the effect of size of field upon the surface intensity. The ionization chamber, no matter how small, is not the ideal indicator for this work. The invaluable work of Dr Francis Carter Wood and others, with *Drosophila* eggs, points the way to a real determination of the value of the scatter-back figure.

#### CONCLUSION

The large ionization chamber of the In-

ternational Standard type must remain the instrument for the primary determination of the r, but is applicable only to the x-ray beam, in air.

The large ionization chamber of the "wall" type, permanently placed in the filter position, and used in conjunction with a galvanometer or micro-ammeter, is of value as a check upon the constancy of the x-ray output.

At present, the most accurate method of determining the intensity upon the patient's skin is to determine the output in r, measured in the beam, without scatter-back, and then to calculate the skin intensity by referring to charts and tables based upon area irradiated, volume and type of tissue, and technical factors. It is to be hoped that further work with *Drosophila* eggs or some other biological medium will enable us to increase the accuracy of these calculations, but even with the incomplete figures at present available, one can arrive at a closer approximation by the above method than by placing a thimble ionization chamber upon the patient's skin.

## ROENTGEN PELVIMETRY<sup>1</sup>

### A DESCRIPTION OF THE GRID METHOD AND A MODIFICATION

By HERBERT THOMS, M.D., F.A.C.S. Yale University School of Medicine  
NEW HAVEN, CONN.

From Department of Obstetrics and Gynecology, and the Department of Roentgenology

FOR the past ten years, this Clinic has been interested in roentgen pelvimetry.

During that period, we have, by means of numerous communications (see references), endeavored to emphasize the importance of applying roentgenometric methods of diagnosis to the problems of pelvimetry.

(6), fetal cephalometry (8, 9, 10), and the determination of fetal maturity *in utero*. At the present time we are convinced that only by roentgenometric means may the true proportions of the superior strait be determined, and, furthermore, that the ordinary external methods of pelvimetry are not only occasionally fallacious, but they may be quite misleading.

The present communication deals primarily with the method that we are now em-

<sup>1</sup>I wish to express my gratitude to the late Dr. W. A. LaField for his interest and the fine co-operation of his department in offering every possible aid in the furtherance of these studies. This paper was submitted for publication prior to his death and I am glad to say that due acknowledgment was made to him during his lifetime.

playing for pelvimetry. For those interested in fetal cephalometry, attention is directed to references to that subject (8, 9, and 10). In this communication it is the intention to repeat somewhat the description

- 3 The tube target is centered about 5 cm posterior to the symphysis, at 32 in from the sensitized film. The exposure is made.
- 4 The patient is removed from the table.

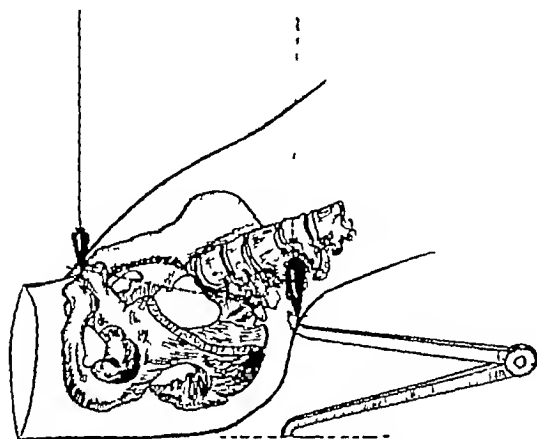


Fig 1 Measuring the distance of the superior strait above the sensitive plate by means of calipers and plumb lines

of the technic described in 1929 (6) and, in addition, to demonstrate a modification which may prove useful.

Any procedure of this kind, to be of use, must be simple, rapid, and accurate. Furthermore, it must be available for use by others than experts in roentgenologic or obstetric diagnosis. All of these conditions seem to be fulfilled by the method herein described. Indeed, for the past two years the majority of our pelvigrams have been taken solely by a technician trained in our Roentgenologic Department.

#### CENTIMETER GRID METHOD

Our procedure in this method may be summarized by stating the following:

- 1 The patient is placed on the roentgenographic table in the semirecumbent position.
- 2 The level of the superior strait above the sensitized film is established (Fig 1).



Fig 2 Adhesive tab placed for identification on "posterior point" i.e., the space between the fourth and fifth lumbar vertebrae

the tube target and sensitized film remaining *in situ*.

- 5 A lead plate, or centimeter grid, with perforations exactly 1 cm apart is introduced into the same plane as that previously occupied by the superior strait and a second (flash) exposure is made on the same sensitized film as was used in the previous exposure (Fig 3).
- 6 Development of the film shows the outline of the superior strait and the shadows of the perforations; the distance between which represent centimeters in the plane of the superior strait (Fig 4). The anteroposterior and transvers diameters of the superior strait may be read directly. In addition a pelvigraph of the superior

strait in its true proportions may be drawn on centimeter-squared paper by following the course of the shadow of

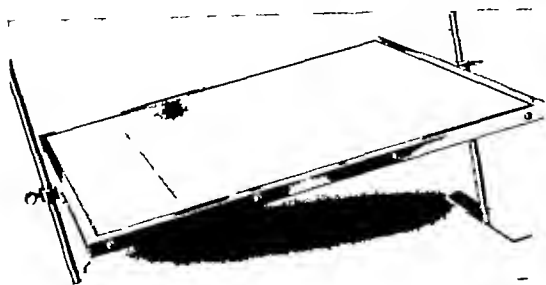


Fig 3 The centimeter grid Under the thin aluminum protective sheet is the lead grid with perforations exactly 1 cm apart By means of the supports, the grid may be raised and lowered to any position

the superior strait and transcribing it (Fig 6) In the modification presented later in this communication this becomes a matter of simple tracing

#### POINTS IN DETAIL

1 Two points on the external body of the patient must be identified, namely, a point on the anterior surface about 1 cm below the upper and anterior border of the symphysis pubis, and a point on the back at the interspace between the fourth and fifth lumbar vertebræ For purposes of identification, this is marked usually with a small adhesive tab (Fig 2) An imaginary line between these two points traverses the anteroposterior diameter of the superior strait The accuracy of this imaginary line, for all obstetric purposes, is entirely adequate

2 The patient is placed in a comfortable position on the roentgenographic table The back is supported by means of a back rest, and the patient assumes the semirecumbent position A foot board at the end of the table serves to steady the patient The lower 6 in of the back is uncovered and the surface of the body over the symphysis and lower abdomen are made ready for palpation

3 The distance of the posterior adhesive tab above the table is measured with calipers and the point at which the lower arm comes

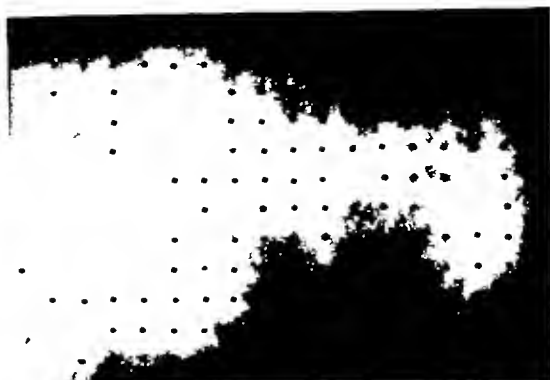


Fig 4 Roentgenogram of a small round pelvis The diameters of the superior strait read directly anteroposterior, 9.75 centimeters, transverse, 10.5 centimeters

in contact with the table is marked The level of the anterior point at the symphysis pubis is fixed by a plumb bob (Fig 1)

4 The target of the tube is centered at a point about 5 cm posterior to the upper border of the symphysis, from 30 to 36 in above the sensitized film Usually we use a 32-in distance The exposure is made We have not felt that it is essential for the patient to hold her breath The technic of exposure, etc, is essentially that of taking the usual anteroposterior pelvic roentgenograms The exposure is varied, of course, with the individual patient, thickness of tissues, etc

5 With the tube and sensitized film still in position, the patient is removed from the table The centimeter grid is placed in the same plane as that occupied by the superior strait This is accomplished by bringing the anterior portion of the grid under the anterior plumb bob, and for the posterior point, bringing another plumb bob down to the point of the upper arm of the posterior caliper measurement (Fig 1) The anterior and posterior portions of the grid touch, on the upper surface of the grid the points



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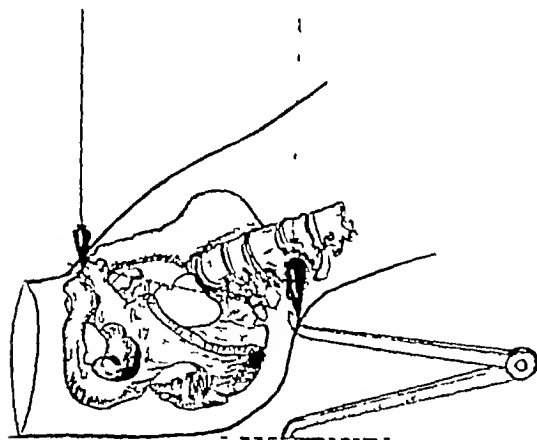


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uring the true distance of the superior strait above the film, indeed, he should be, with but little experience, within an error at least of 2 cm, in which case an error of not more than 0.25 cm may be expected in the result.

Assuming, furthermore, that the identification and establishment of the level of the anterior point, or symphysis pubis, can be made to a point of accuracy within 1 cm, the problem becomes essentially the determining of the posterior point, *i.e.*, the space between the fourth and fifth lumbar vertebrae. Our experiments have shown that this posterior point may vary as much as 4 cm before an error of 0.5 cm occurs in the result. I am convinced that the method is reasonably accurate for portraying the true contour and diameters of the superior strait with an error, at most, of from 0.2 to 0.3 centimeters. This is all that practical obstetrics demands.

It is true that to depict a somewhat simple procedure in words oftentimes makes the subject appear to be one of complexity, and those who have seen our technic will bear me out that in this instance such is the case. We rarely take more than 15 minutes for the entire procedure, allowing six minutes for the development of the film.

#### MODIFICATION OF THE GRID METHOD USING THE PELVISCOPÉ

In determining the usefulness of a modification by which the distortion, due to divergence of the rays, level of the superior strait, etc., might be corrected visually by the examiner, the apparatus depicted here (Fig 5) has proved useful. The eye of the examiner occupies the position of the target of the x-ray tube and views the developed film through a glass centimeter grid placed in the position formerly occupied by the superior strait of the patient. The level of the superior strait for this latter purpose may be determined by means of the plumb bobs or entirely by calipers measuring from the sensi-

tive film to the points of identification above. We use the latter method.

We place directly on the sensitive film identification marks (iron washers), resting on the film holder, marking the following

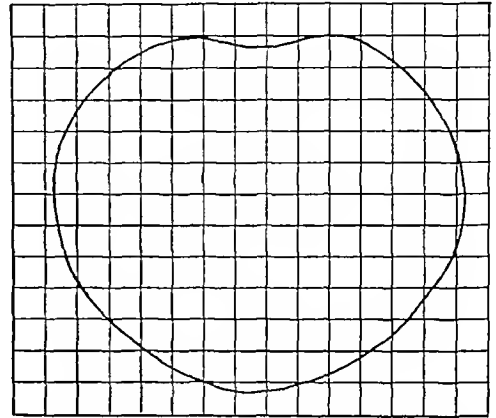


Fig 6 Pelvigraph used in this Clinic for filing with the patient's chart. The superior strait is shown in its true proportions.

three points: (1) the center of the film under the target, (2) the point under the symphysis which represents the point of contact of the lower arm of the calipers, (3) the point under the posterior pelvic measurement which represents the point of contact of the lower arm of the calipers in this position. It is obvious that the eyepiece of the viewer must be in same horizontal plane as the center of the developed plate in the viewing box. In other words, the conditions which obtain vertically in making the exposure are made horizontal for convenience.

When the developed film is viewed, it becomes possible to trace with a wax pencil the course of the superior strait directly on the glass grid, this tracing representing the true superior strait. It may then be traced directly on centimeter paper, which can be filed with the patient's chart (Fig 6).

For want of a better term I have called this apparatus a "pelviscope." It has one advantage over the centimeter grid method in that a tracing of the superior strait in its true proportions becomes available. How-

of the plumb bobs. With the grid in position, a second (flash) exposure is made on the previously exposed plate.

- 6 The plate is developed and viewed.
- 7 The centimeter grid (Fig 3), which

patient (*ie*, the space between the fourth and fifth lumbar vertebra) may appear to be a little indefinite. Therefore, from our experiments of this latter kind we found that a liberal latitude, or leeway of proce-

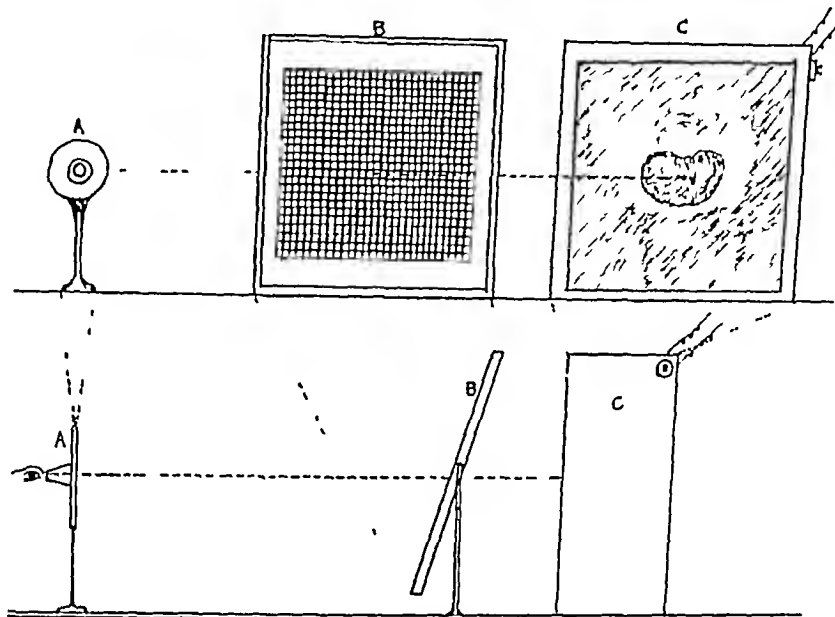


Fig 5 The pelviscope—an apparatus for viewing roentgenograms of the superior strait through a glass centimeter screen *A*, eyepiece, *B*, glass centimeter screen, *C*, viewing box

is manufactured for me, must be very carefully calibrated.

#### ACCURACY OF THE METHOD

From the clinical point of view, we have on numerous occasions tested the accuracy of the method both on dried pelvises and in living patients. In the latter we have been able to check our results at laparotomy, measuring directly the anteroposterior diameter of the superior strait. We are convinced from these clinical experiments that the method is accurate to within 2 mm, which, for obstetric purposes, we feel is entirely adequate.

We have also conducted a series of experiments by means of line projections and shadowgraphs. We realize that the finding of the posterior point on the surface of the

pelvis, was possible without materially affecting the end-results.

Some results of these experimental procedures may be of interest. Assuming that the superior strait is parallel to the film at a level 15 cm above the film, and the target of the tube is 32 in above the film and centered over the superior strait, and that the anteroposterior diameter of the strait is 11 cm, at this 15 cm-level the divergence of the rays will produce a shadow, making this diameter 13.5 cm on the plate. At the 13 cm-level, the divergence will give 13.25 cm on the film, at the 17 cm-level the divergence will produce 14 cm on the film. In other words, in a 4 cm-difference of level, there is a difference of but 0.75 cm in the shadow, which represents but 0.6 cm in the final calculation. The examiner will certainly be well within a 4 cm-error of meas-

uring the true distance of the superior strait above the film, indeed, he should be, with but little experience, within an error at least of 2 cm, in which case an error of not more than 0.25 cm may be expected in the result.

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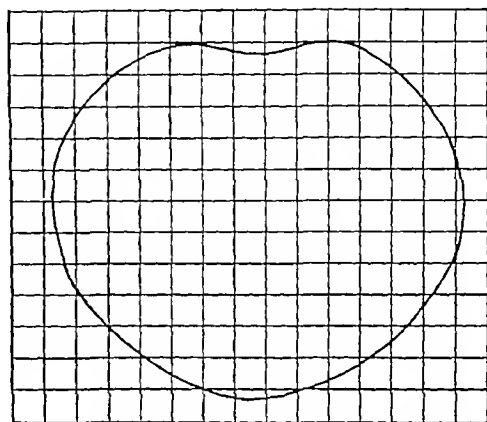


Fig 6 Pelvigraph used in this Clinic for filing with the patient's chart. The superior strait is shown in its true proportions.

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For want of a better term I have called this apparatus a "pelviscope." It has one advantage over the centimeter grid method in that a tracing of the superior strait in its true proportions becomes available. How-

ever, it is obvious that the pelviscope may be used in combination with the centimeter grid method in which case the glass grid is placed between the eye of the observer and the viewing box containing the developed film with the dots of the lead grid. It is adjusted in such a way that the cross-sections of the glass grid superimpose exactly the dots on the film. When this is accomplished the tracing may be made which represents the outline of the superior strait in its true proportions.

To those interested in cephalometry *in utero*, the pelviscope should prove useful. Not only may the occipitofrontal diameter be determined as in the grid method but a tracing of the profile of the cranium in its true proportions can be made. This should prove helpful not only in studies having to do with fetal maturity *in utero*, but in investigations concerning the effect of labor upon the molding of the fetal head.

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## ROENTGENOGRAPHY OF ACUTE BRONCHOPULMONARY DIPHTHERIA IN ADULTS<sup>1</sup>

By NOXON TOOMEY M.D., F.A.C.P. PALMYRA, MISSOURI

THE gravity of acute tracheobronchial diphtheria without laryngeal, faucial or nasal symptoms to warn the practitioner, the rarity of the disorder in adults, and the paucity of literature on the subject, with the general unfamiliarity of practitioners concerning it, justify, we believe, the reporting of the two cases that the author has had the opportunity to study.

Diphtheria of the trachea and bronchi is a well known condition when extension from the larynx is taken into consideration. Most

physicians very likely recollect illustrations showing diphtheritic membranes removed from the respiratory tract as a more or less perfect internal cast of the trachea and larger bronchi. So almost invariably are cases of the sort secondary to laryngeal faucial, or nasal diphtheria that it was at first and for a long time, believed to be absolutely the rule for tracheobronchial diphtheria to be an extension from a superior focus. Hence, for a long time the only recognized primary bronchopulmonary episode of diphtheria was the bronchopneumonia that was well known to complicate

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4 1931.

not a small portion of the cases, particularly in infancy and early childhood. This bronchopneumonia was generally believed to be due to secondary organisms, even after diphtheria bacilli had been demonstrated by culture to be present in the areas of bronchopneumonia in from one-half to two-thirds of the cases (20). Even in the exceptional cases in which the diphtheria bacilli appeared to be in pure culture in the pneumonic areas, there was, or was assumed to be, clinical evidence of diphtheria in the fauces, nose, or larynx.

The dictum that diphtheria is always primary above the larynx was, however, shown to be erroneous (at least for infants and children), by the careful clinical work of Jacobi (6). Up to then intimations of the occurrence of a primary tracheal diphtheria in children had been asserted by a few (1, 2, 3, 4, 5), and those who quoted them approvingly, but the fact was denied by Orth, Hans Eppinger, and Samuel Gee Place (21) and others have said it was not according to their experience. Thus it is to Jacobi that we are indebted for the first indisputable evidence that diphtheria in childhood occurs occasionally as a primary focus in the trachea, without laryngeal involvement at the outset. Jacobi even showed that in such cases an extension upward ("ascending croup") to the larynx, although it usually occurred, was not invariable.

When laryngeal involvement develops, as it sometimes does, there is, of course, little thought or practical attempt to ascertain if there was a preceding tracheal focus. The laryngeal involvement gives warning so that antitoxic serum is often resorted to in time to prevent a bronchial occlusion; hence the extent of the tracheobronchial involvement never is known. That laryngeal involvement does not occur secondary to tracheobronchial diphtheria in all cases is, however, a distressing and often fatal fact, as such cases are cared for inadequately, due to the

misconceptions arising from an erroneous diagnosis.

In adults, diphtheria of the tracheobronchial mucosa has been observed in an extremely wide range of virulence, from fulminating cases of the most acute, malignant character to those of a chronic, even inveterate, type without toxemia and with local symptoms of only a minimal or moderate character. Some symptoms are a plastic (pseudomembranous) bronchitis (36), a fetid bronchorrhea (29), or possibly only a catarrhal (33) or obliterative type of bronchitis (32). The chronic type is caused by avirulent diphtheria bacilli (35). It is uncertain what proportion of the chronic cases are secondary to a supralaryngeal diphtheritic infection, probably the majority are, although some are very likely primary tracheobronchial infections.

The chronic type will not be further referred to in this paper as the author's experience has been with the malignant fulminating and the acute virulent types of bronchopulmonary diphtheria.

Among the cases of tracheobronchial, membranous (pseudomembranous) inflammation reported in the epoch before the discovery of the *Corynebacterium diphtheriae* by Löffler, in 1884, undoubtedly a few instances of primary and of secondary tracheobronchial diphtheria in adults were reported under such names as (pseudo) membranous bronchitis and croupous tracheitis. But it would not now be proper to attempt to specify the cases because there is lacking bacteriologic proof concerning their nature.<sup>2</sup>

With the exception of the unconfirmed cases referred to above, the first to call attention to tracheobronchial diphtheria in adults was Goodall (23) in 1895 and Ewart

<sup>2</sup> For the early case reports consult the Index Catalogue of the Surgeon General's Library, U. S. Army, Vol. II, pp. 480-481, title "Bronchitis, pseudomembranous," Vol. XIV, pp. 689-690, title "Trachea, diseases of," and "Inflammation of," Second Series, Vol. II, pp. 835-836, title "Bronchitis, fibrinous, croupous, plastic, and pseudomembranous," Vol. XVIII, pp. 414-418, title "Trachea, diseases of," and "Inflammation and abscess of," as well as the bibliographies under "Croup" and "Diphtheria."

and Hunt some four years later (28) From their meager reports, it seems, however, that Goodall's and Ewart and Hunt's adult cases were both secondary to pharyngeal or laryngeal diphtheria. Numerous bacteriologically verified cases of primary tracheobronchial diphtheria in children have been reported since 1893 (7, 8, 9, 10, 11, 12). With the exception of eight additional acute cases in adults (13, 21, 25, 27, 30), the only other cases in adults that have been reported were of the chronic type (32, 33, 34, 35, 36). Trousseau was said to have had a case of primary tracheobronchial diphtheria some time prior to 1898 but I have been unable to find details concerning it (21, 24). In 1917 Dr W. G. MacCallum, the pathologist, told me that he knew of an unreported, fulminating case in an adult, and that he considered the condition extremely rare.

The subject has been most broadly discussed by Lynah (13, 37), who has had considerable bronchoscopic experience with tracheobronchial diphtheria in infants, children, and adults. Lynah wrote as follows:

"I am firm in my belief that the great majority of these membranous stenoses travel from below upward, and this statement is borne out by direct laryngeal and bronchoscopic examination on cases recognized prior to the third day of the disease, the larynx not being involved, and diphtheritic membrane encountered only when the lower trachea and bronchi are reached when the foreign body obstruction is plainly visible.

"If in all of these cases the membrane started primarily in the larynx, we would never fail in our diagnosis, for the constricted cough of the laryngeal type would put us on our guard, but such is not the case in these low membranous types of diphtheria. This condition starting primarily in the bronchi is, I feel, overlooked in many instances and diagnosed bronchopneumonia. If one will only bear in mind that there is such a disease as bronchial diphtheria which may be mistaken for bronchopneumonia, and be constantly on

the lookout for the former condition, I can see no reason why any grave error in diagnosis should be made. I wish to make myself perfectly clear on this point, and not lead anyone to believe that I consider all of the secondary and latent pneumonitis tracheobronchial diphtheria, I am speaking of the primary involvement of the lung, accompanied by marked cyanosis early in the disease, asthmatic dyspnea, and peculiar but inconstant physical signs distinctive of bronchial obstruction" (13).

Of 50 cases of tracheobronchial diphtheria reported by Lynah, 22 of the 47 juvenile cases, or 46.8 per cent, were definitely primary below the larynx, while five cases were possibly so, thus about one-half of all his cases of tracheobronchial diphtheria in infants and children were primary below the larynx. None of Welford's 24 cases at the Chicago Contagious Disease Hospital was in adults (16), these, with other known juvenile cases, would give a ratio of seven juvenile cases for every adult case.

Although the series is too small to afford statistical data, it may be said that, of the acute tracheobronchial cases in adults reported to date (Table I), seven were in women and five were in men, four were primary tracheobronchial and eight were secondary to laryngeal and/or pharyngeal diphtheria. Seven died and five recovered.

TABLE I—TWELVE ADULT CASES REPORTED TO DATE

Observer	Sex of Patient	Age	Location	Termination
Goodall (23)	Female	18	Secondary	Death
Ewart and Hunt (28)	Female	32	Secondary	Recovery
Levinson (30)	Female	50	Secondary	Death
Lynah (13)	Female	24	Secondary	Recovery
Lynah (13)	Male	30	Probably primary	Death
Lynah (31)	Female	35	Secondary	Recovery
Dupuy (26)	Female	22	Primary	Death
MacCallum (25)	Male	25	Secondary	Death
Price (21)	Male	?	Secondary	Recovery
Bly (27)	Female	67	Secondary	Death
Toomey	Male	28	Primary	Death
Toomey	Male	23	Primary	Recovery

## CASE REPORTS

Case 1 C O, male, age 28 years, enlisted man, Medical Department, National Army, detailed as ambulance driver (motor) Born of Scandinavian and German parentage Height, 6 feet, weight about 180 pounds, robust, but below average muscular development. There was suggestion of lymphatic habitus Previous health, as far as was remembered, had been satisfactory and without any wasting ailment in recent years Patient had never had diphtheria The previous medical history had otherwise no bearing on the present illness He was considered to have had no minor ailment immediately preceding the present illness

*Present Illness*—The patient returned from a tour of duty as motor ambulance driver at 2 00 P M, Dec 1, 1917, feeling his usual self At 4 00 he felt a trifle queerly and rested on his bunk until 6 00, when he went to mess with accustomed appetite After eating a satisfactory supper he remained in his quarters playing cards and smoking, but retired at tattoo (9 00 P M) as he then felt a little more tired than usual He slept well until 4 00 A M, when he awoke feeling cold, but he had no rigor or semichill He slept brokenly until 6, then arose without definite discomfort and ate breakfast with relish He *reported* to me *for duty* at 7 50 A M Although I remembered having seen the man on only one or two previous occasions, I observed a marked pallor, and, despite his protestations of feeling well, I told him he looked too ill to go to duty A preliminary examination, which included inspection of his pharynx elicited chiefly a pulse rate of about 124, a temperature of 101° F, and, seemingly, a somewhat shallow respiration of slightly increased rate The tonsils and fauces buccal mucosa and anterior nares had all appeared quite normal and certainly presented nothing to arrest the attention

Marked pallor, the first sign noticed, was then observed to be suffused with a tinge of cyanosis The heart was clearly not decompensated, although rapid and weak, and there was no evidence of acute dilatation of the stomach or gastric distress There had been no history of traumatism The abdomen nowhere showed tenderness or rigidity Stethoscopic examination of the chest yielded barely audible sounds of an extremely irregular, bizarre character, chiefly whistling, and bronchial râles Percussion of the thorax excluded the existence of a wet pleurisy Feeling assured that the man was seriously ill, although he admitted to only some sense of muscular weakness, "shakiness," and a little difficulty in clear vision at near distances, I decided to re-examine his throat, although it certainly had looked perfectly normal and without so much as a plug of mucus coming from his nasopharynx

On re-examining his throat, I inserted my finger to his epiglottis, suspecting, from the sounds in his chest, some foreign body or painless lesion in a paralaryngeal sulcus, notwithstanding his retaining normal deglutition and voice sounds The maneuver to retract the base of his tongue and expose his larynx for inspection (under direct sunlight), which was momentarily successful (and showed nothing visible), caused him to cough and strangle violently The cough, the first he had had, brought up a strip of false membrane about 2 cm wide by 15 cm long, which I extracted manually Continued strangling and coughing brought up two more pieces of equal or slightly smaller size The man, who was then cyanotic, prostrated, and in a cold sweat, was wrapped in blankets and placed recumbent on a wheel-litter, on which he was sent at once (then about 8 15 A M) to a recovery room at the nearest ward Recognizing the false membrane as almost certainly diphtheritic, especially in view of the man's apparent impend-



ing circulatory collapse, I sent it by orderly to the laboratory with request for immediate direct smear and report by telephone. I ordered all the available anti-diphtheritic serum to be sent to the ward, and notified the Chief of Medical Service. A positive Klebs-Löffler report was received, and, as I was primarily in an executive capacity at the Base Hospital, I turned the case over to the chief.

All available anti-diphtheritic serum (some 16,000 units) was given to the man (intramuscularly only) about 9 00 A. M. As the man was moved to the diphtheria isolation ward he was passed through the X-ray Department, and a stereoroentgenogram was made about 9 30 A. M.

About 11 00 A. M., the patient commenced to cough up more membrane, gagging and strangling considerably. Although under the constant care of medical officers, the man died suddenly of acute cardiac dilatation, undoubtedly superinduced by a strangling spell, at 11 20 A. M., or exactly three and a half hours after he proposed going to duty.

Necropsy the same day showed the trachea and all primary and secondary bronchi to be covered with a thick, glairy, translucent, non-hemorrhagic tenacious pseudomembrane. Long denuded areas represented the site of the pseudomembrane, which was coughed up. The pseudomembrane was about equally distributed between the two lungs, but there was a preponderance in the lower lobes. In the latter, most of the smallest bronchi showed a thin, glairy coating of fibrinous exudation. There were no areas of acinus or bronchopneumonia. The pleural cavities contained a small excess of serofibrinous exudate and the pericardial sac proportionately more about sixty cubic centimeters. Cultures from the heart wall, ventricular blood, liver, and spleen were all positive for Klebs-Löffler bacilli. The heart was in extreme diastole.

The nasal sinuses, nasopharynx, fauces, tonsils, and larynx showed nowhere any engorgement or plastic involvement, they were culturally negative for Klebs-Löffler bacilli. There were no subcutaneous or visceral hemorrhages except for numerous minute, subendothelial hemorrhages in the ventricular (cardiac) cavities.

The stereoscopic roentgenogram showed an almost bilaterally equal, fairly uniform, feathery opacity throughout most of the chest but with greater density in a very wide central zone, the apices being virtually free from abnormal shadows and the inferior borders almost so. The bronchial architecture was distinctly visible through the general feathery opacity. The heart was moderately dilated.

The differential white count was normal, at least not characteristic, and the leukocyte count was about 13 000. The erythrocytes showed marked basophilic degeneration (stippling) but were otherwise normal.

Case 2. J. F. single, male 23 years of age, student at business college. Stature 71 inches, weight 115 pounds of Irish descent, third of five children.

The physical development had been compromised since the third year of life by extensive infantile paralysis which left the patient with a withered left arm, a weak right arm, and a paralytic type of chest, but with almost complete recovery in his lower limbs. There had been a light attack of influenza 12 years earlier, but otherwise no acute illness since childhood and no diphtheria. The tonsils, which had been chronically infected for many years occasionally became subacutely inflamed and caused a moderate degree of secondary anemia. A tendency to catarrhal nasal sinusitis manifest only in changeable weather, had only very slightly compromised nasal ventilation but with his chronic tonsillitis it had at times occasioned a non-productive cough. The latter with his paralytic type of chest had popularly

fixed on him the suspicion of pulmonary tuberculosis. There was no evidence of an essential deficiency in diet. The environment was that of a rural home adjoining a small town. Immediately prior to present illness the patient had been physically depreciated by a motor drive, twice daily, of 35 miles in addition to his school work.

*Present Illness*—While attending school, patient sat next to a fellow-pupil who had a severe sore throat. There had been no diphtheria or other exposure in the town in which the patient resided. The illness began Nov 12, 1930. He first noticed a "tightness of the chest" as though he had a "deep cold on his lungs," but without the least pain. He did not cough, and otherwise felt his usual self except that he noticed he was more sensitive to cold wind than usual (it was a windy day), but the young man did not have even a slight rigor or "creepy, chilly sensation." He slept well that night after drinking a hot lemonade to "break up the tightness of his chest."

The following day he arose, feeling well enough to go to school. While cranking his automobile he found his mouth suddenly filled with large quantities of blood, something that had never happened to him before. He consulted a doctor, who gave him some medicine and advised rest, intimating his diagnosis was pulmonary tuberculosis.

The patient remained at home but experienced a recurrence of hemoptysis late on the day he consulted the doctor and frequently in the following two days, with increasing weakness, hyperhidrosis, some feverishness, and loss of appetite, but without soreness of throat, hoarseness, difficulty in swallowing or cough, except with hemoptysis.

The following day, as the hemoptysis continued profusely and almost constantly, the physician whom he had consulted was summoned to the patient's home. The doctor left some pills and advised sending for the priest as he anticipated a fatal outcome

and was understood to say he could do nothing for him.

November 17, four days after the definite onset, I was summoned to patient's home at noontime. The patient was then constantly expectorating large quantities of blood (but no membrane), was too weak to move from a semi-reclining position, had a fever of 102° F, respiration of 26, great anxiety, and a tense pulse of 132. His nose and throat were absolutely negative. No headache or thoracic pain had been noticed. White blood count was 11,500. Following morphia (gr 0.5) by hypodermic and an icebag to his precordium, the hemoptysis ceased except for blood-tinged sputum (without membrane). Seven hours later, after fluids had been forced, and morphia repeated, the patient was removed to the hospital for stereoscopic roentgenogram of chest and for laboratory examination. A throat culture was made routinely but was anticipated by direct smear of pulaceous material that the patient was caused to cough up during the process of inspecting his larynx, which showed no visible exudate.

*Laboratory Findings*—Nov 18, 1930 8 00 A M. Hemoglobin 65 per cent, red blood count, 4,670,000, index, 0.8, white blood count, 7,500, segments, 67 per cent, stabs, 14 per cent, lymphocytes, 15 per cent, large mononuclears, 4 per cent. Throat culture (taken 15 hours before) was negative (1) for diphtheria bacilli. Antiformin preparation for tubercle bacilli was negative. Repeated swabs from the nose and throat were negative for diphtheria bacilli by culture and direct smear.

November 18, the smear having showed immense quantities of diphtheria bacilli (Albert's stain) and apparent absence of other organisms in the pulaceous material obtained from the trachea, the patient was given 30,000 units of diphtheria antitoxin intramuscularly and, 20 minutes afterwards 10,000 units intravenously, for quick effect. An additional 10,000 units were given in-

travenously 12 hours later. This amount was considered necessary in view of the impending circulatory collapse and the extensiveness of the bronchopulmonary involvement as demonstrated by stereoscopic roentgenograms.

The roentgenographic picture (Fig 1)



Fig 1 Case 2. Roentgenogram taken four and one-half days after first hemoptysis, or six days from probable time of onset. Posterior view, but reversed and viewed from in front.

was that of a hilus and proximal, to more or less distal, peri-truncal infiltration of comparatively slight density. A diffuse hazy to feathery appearance prevailed, with margins not so sharply defined as in the pneumonias and bronchopneumonias of pneumococcal and septic origin.

In general, there was a tendency to radiate upward, laterally, and downward from the hilus, the latter two directions predominating. This radiation in several directions distinguishes the condition from occlusion of a bronchus by a foreign body.

The centering of the density around the hilus and large bronchi, without outlying isolated areas of density, distinguishes this condition from bronchopneumonia met-

astatic malignant foci, multiple abscesses, etc. Either or both lungs may be affected. The comparative slight density was probably due to the fibrinous character of the exudate. This latter contained less iron and chloride and phosphate salts of the alkali earth elements than does blood and the cellular infiltrates.

No membrane or pultaceous material was brought up at any time following the injection of the antitoxin. Improvement was so dramatic that no cardiac or respiratory stimulant seemed necessary, hence none was administered. Morphine (gr  $\frac{1}{8}$  by hypodermic) was replaced by codein (0.5 gr) every three hours by mouth. Hyperhidrosis, apprehension and sense of thoracic constriction ceased within a few hours, cyanosis disappeared rapidly, and the appetite returned gradually. The cough became more persistent for two or three days, although the markedly (bright red) blood-tinged sputum was of small quantity, thin (slightly frothy), and easily raised.

The temperature, which was  $104^{\circ}$  F on admission to the hospital and  $103^{\circ}$  F just prior to administration of antitoxin, rose to  $106^{\circ}$  F (with chill) one hour later. It dropped to  $100^{\circ}$  F by the forty-eighth hour, and never afterwards rose more than one degree, thus excluding a co-existing bronchopneumonia of pneumococcal, streptococcal, or related type. The respirations diminished from 26 per minute before administration of antitoxin to 20 per minute by the thirtieth post-antitoxin hour.

On November 19 the patient was removed to his home, still very weak and with a pulse rate of 130. Some precordial pain was noticed despite absolute bed rest. Insulin, units from 10 to 12 and about twenty-five grams of glucose (100 gm of cheap candy) were taken thrice daily for five days, twice daily for the next five days, and once daily for the next four days.

After 10 days of absolute bed rest the

patient was allowed up gradually, and was able to walk out-of-doors by the end of the following week. He was not, however, fully ambulatory until about December 10, about four weeks after onset. However, as considerable shortness of breath persisted noticeably, the patient was placed on strychnine in fairly large dosage and Fowler's solution in small dosage. Various combinations of these drugs, cod liver oil, and an iron tonic were employed intermittently and in generally decreasing dosage for the following five months, as the patient came to office saying he felt the need of them, and experienced considerable benefit when he took them.

By May, 1931, the patient had ceased to notice any shortness of breath on exertion and had gained 15 pounds in weight above pre-diphtheritic norm.

#### SUMMARY

A review of the literature clearly indicates the extreme rarity with which primary bronchopulmonary diphtheria in adults, without secondary laryngeal or faucial involvement, has been recognized and reported.

Some cases of "laryngeal diphtheria" are primarily tracheobronchial. Taking these cases and the unrecognized bronchopulmonary cases into consideration, primary tracheobronchial diphtheria in adults is not so extremely rare as the paucity of literature on the subject would indicate.

The obscure nature of the ailment, its rarity and the lack of common knowledge concerning it makes early diagnosis unlikely although not difficult when once suspected. As a little known cause of preventable deaths it should receive wider recognition.

A rapidly developing toxemia of insidious onset with pallor, bronchial obstruction, cyanosis, or other symptoms of impending circulatory collapse should especially in the presence of abnormal auscultatory signs

over the chest, lead to pseudomembrane in the bronchi being sought for by direct smear, expulsion (induced coughing), and by roentgenogram, despite absence of inflammation or fibroplastic exudate in the fauces, nasopharynx, or larynx.

As early diagnosis is of vital importance if life is to be saved, it is believed that roentgenologists should be especially acquainted with this condition and its radiographic appearance. A large proportion of these cases will be recognized early by radiography rather than by cultural or bacterial inspection methods, due to the negative aspect of the fauces, larynx, and nasopharynx.

A chronic type of diphtheritic tracheobronchitis has been described by others.

The prognosis is extremely grave, virtually fatal for fulminating cases, but, for those of moderate virulence, the prognosis is slightly better than for laryngeal diphtheria of like virulence, provided a correct diagnosis is established within three or four days of onset. A single massive dose of antidiphtheritic serum should be immediately given, partly intramuscularly and partly intravenously, and the heart is supported by absolute rest, insulin, and suitable cardiac stimulants, both primarily and also during the period of delayed cardiac deterioration.

Two cases, both in young adult males, are reported, one of the fatal fulminating type, and one of intermediate virulence, with recovery following the employment of only antidiphtheritic serum in large dosage intramuscularly and intravenously, and insulin and glucose to support the heart.

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duces a sharp image of objects at varying distances and conveys the knowledge of these differences to our mental conception Wundt, in 1862, published the following data concerning the role of accommodation for the recognition of depth

RECOGNITION OF VARIATION OF DISTANCES  
BY ACCOMMODATION

Distance of a thread from the eye (cm)	Recognized threshold distances of	
	Approximation (cm)	Removal (cm)
250	12	12
200	8	12
100	8	11
80	5	7
40	4.5	4.5

Wundt concluded that by accommodation alone absolute distances could not be judged at all, approximation and removal, however, could be recognized with certain limits. Convergence is the result of the co-operation of both eyes which observe identical subjects from different viewing points—parallactic observation. The angle enclosed between the axial rays of the individual viewing beam (viewing line) is greater, of course, for close objects than for distant ones. This angle normally ranges from 0 to 15 degrees. It must also vary individually somewhat with different pupillary distances, which averages 6.5 centimeters. Wundt also published the following data concerning thresholds for recognition of distance by convergence (plus accommodation)

RECOGNITION OF VARIATION OF DISTANCES  
BY CONVERGENCE

Distance of a thread from the eyes (cm)	Recognized threshold distances of	
	Approximation (cm)	Removal (cm)
180	3.5	5
150	3	3
110	2	2
80	2	2
50	1	1

He concluded from his investigations that by our ability of convergence (plus accommodation), without any secondary help, we are unable to correctly judge distance, but

*changes* in distances can be recognized quite well

These important primary factors are of a purely physical nature and will apply equally to roentgen- and photo-stereoscopy. They are individual invariables, entirely beyond our control. Their importance and accuracy, as shown, are limited.

SECONDARY FACTORS

In some respects photographs (visual images) and roentgenograms are principally different records and these differences enter materially into the recognition of space. Photographs depict surfaces, while roentgenograms depict more or less transparent or intransparent objects, the degree of roentgenographic transparency depending upon atomic weight and thickness, neither one of which is in a simple relationship to tridimensional shape and size.

In photographs, objects pictured sharply are recognized as located closer to the observer than those delineated less clearly. The reverse holds true for roentgenograms, as objects close to the film, that is, distant from the observer, cast more clearly defined shadows than those distant from the film and closer to the observer, and as clear-cut roentgenographic demonstration depends to a great extent on the density of the various points of a roentgenogram, it becomes apparent that definition must be an unreliable factor for evaluation of topographic relationship as well as of size and shape.

In the cases of visual observation and photographs we realize that certain objects obscuring others must be located closer to us than the obscured. A similar conclusion cannot apply to roentgenograms, a dense obscuring shadow may be located anywhere within the projecting beam. Consequently, entirely intransparent objects for instance, metals and their salts regardless of their location, usually appear in roentgenograms as homogeneously structured two-dimen-

sional planes—silhouettes. They obscure all other objects covered by the corresponding portions of the image-producing beam, but no simple relationship exists between these silhouettes and the objects casting them

tioned that stereo-roentgenograms as yet cannot be obtained simultaneously with one single exposure and that, consequently, technical efforts are spoiled not infrequently by changes in location and shape of the object

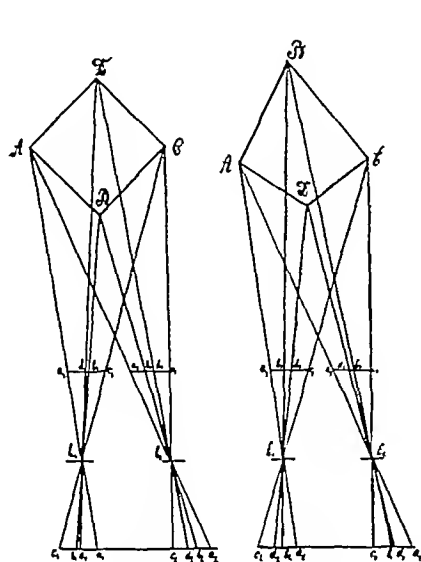


Fig 1

Fig 2

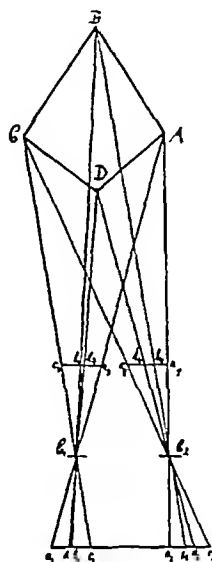


Fig 3

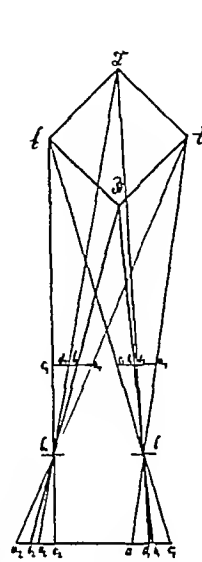


Fig 4

Semi-transparent large objects of homogeneous consistency, on the other hand, permit of demonstration and recognition of their borders, but their internal space, structure, and surfaces are not observed, and a plastic impression—for instance, of a heart, diaphragm, liver, or kidneys—may not be anticipated. They will always appear as flat discs, unless their lumina are made opaque. This, of course, applies also to all other insufficiently demonstrated detail, including such as may be image-producing in unidirectional projections only or may assume quite discrepant shape with parallax projection. Orientation within photographs is facilitated considerably by course, shape, intensity and gradation of lateral shadows, such and is entirely lacking in roentgenograms. Geometric and air-perspective are of considerable importance for our orientation in space and in pictorial images; in roentgenograms these factors are entirely missing.

In this connection it should also be men-

tioned that stereo-roentgenograms as yet cannot be obtained simultaneously with one single exposure and that, consequently, technical efforts are spoiled not infrequently by changes in location and shape of the object.

under investigation. Detail of roentgenograms is less sharply depicted than that of photographs on account of inherent characteristics of the projecting focus, the use of intensifying screens, and the presence of secondary radiation. Contrast of roentgenograms, on the other hand, is usually much greater than that of good photographs, not to the advantage of the record produced, as this will always contain under- and overexposed parts, as a result the continuity and plasticity of roentgenograms are much impaired, especially when contrasts are particularly pronounced. (The latter fact is responsible for quite a few failures of roentgen-stereoscopic observations.)

It is evident that all these secondary factors mentioned belong to the realm of physiologic optics. In this field empiric experience undoubtedly competes with objective physical observation. Unquestionably when observing roentgenograms we are confronted with records for the observation and



evaluation of which all these latter factors are of rather insignificant importance. We, therefore, have to rely chiefly upon observation and recognition based on primary factors only. As roentgen-stereoscopy thus is

delivered to him as poor an optical instrument as our eye, deserved to be discharged. Experience and acquaintance with objects make us overlook apparent mistakes and create the illusion of correct shape. As

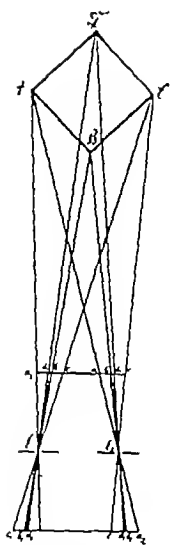


Fig 5

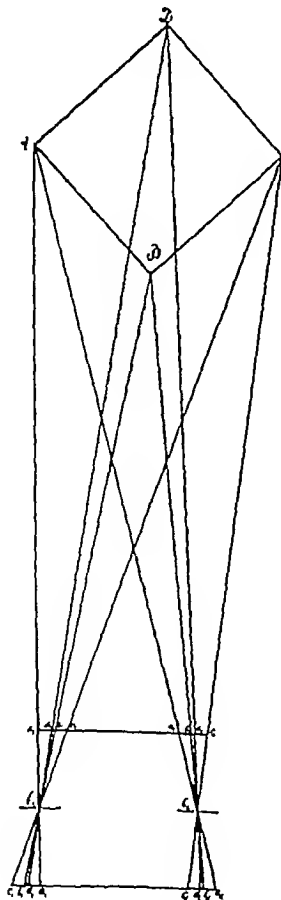


Fig 6

dominated by factors of purely physical nature, one should consistently attempt to comply strictly with well-defined simple physical laws when producing stereo-roentgenograms, and also during their study. It is not to be denied that subjective stereoscopic impressions can be obtained from pictures which by no means fulfill correct physical requirements. Our optic apparatus does not become aware of even gross distortions. Helmholtz, the great physicist, supposedly remarked once that an apprentice who dared

soon as measuring devices are introduced into such images, the disproportions become apparent. Consequently our aim should be



Fig 7

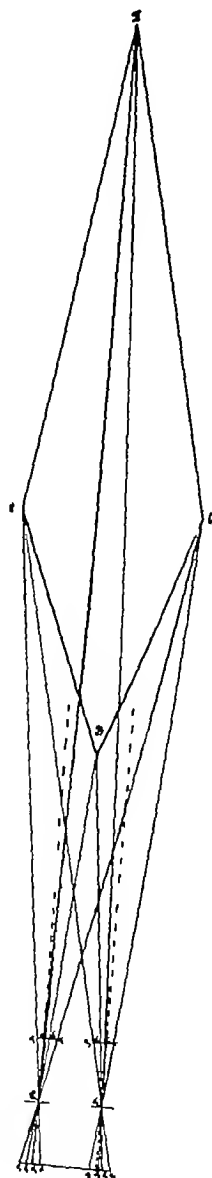


Fig 8

correct objective stereoscopy, which not only creates an esthetic impression or a deceiving illusion but permits of exact, when necessary, measuring evaluation of the records secured

#### GENERAL TECHNICAL CONSIDERATIONS FOR ROENTGEN-STEREOSCOPY

Ordinarily, when stereo-roentgenograms are made, the radiographer merely makes two films, displacing the tube an arbitrary distance between the two exposures. Other conditions are usually little considered.

Rarely is it noted how the films later should be inspected, nor are the displacement of the tube and the distance between focus and films arranged in accordance with conditions prevailing during later inspection of the films. This leads to representations which are spatially incorrect. One should attempt, however, to make each stereoscopic image correspond with angles and distances to the object under investigation, so that one may have not only images correlating space when observed in the customary manner, but images which may at any time be used for ex-

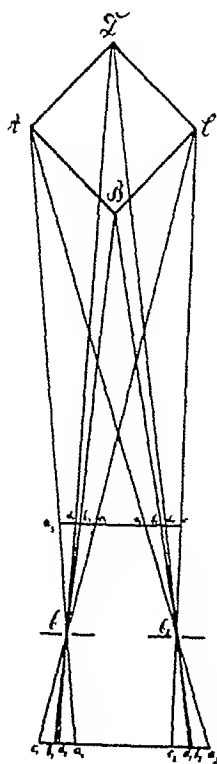


Fig 9

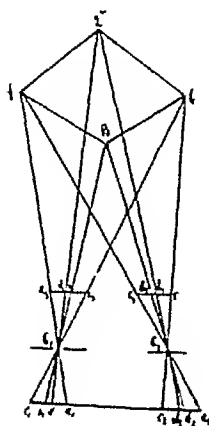


Fig 10

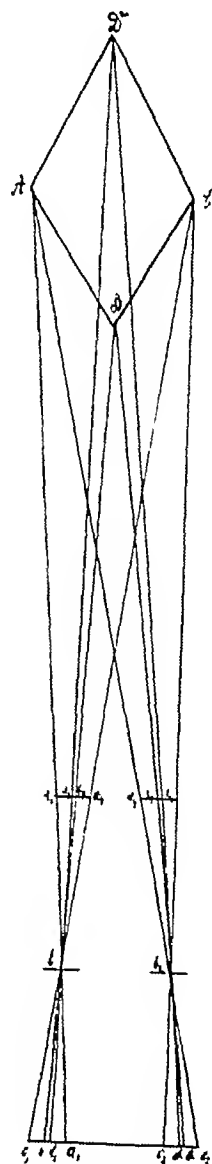


Fig 11

act spatial determinations. We, therefore, strive for so-called tautomorphic images and are satisfied with homiomorphic images only when for specific reasons the tautomorphic representation is less advantageous

of the tube, therefore, should be from 65 to 66 mm (2.55 to 2.6 inches)

3 The central or axial ray in each exposure must strike the film at right-angles from the tube and the point of incidence

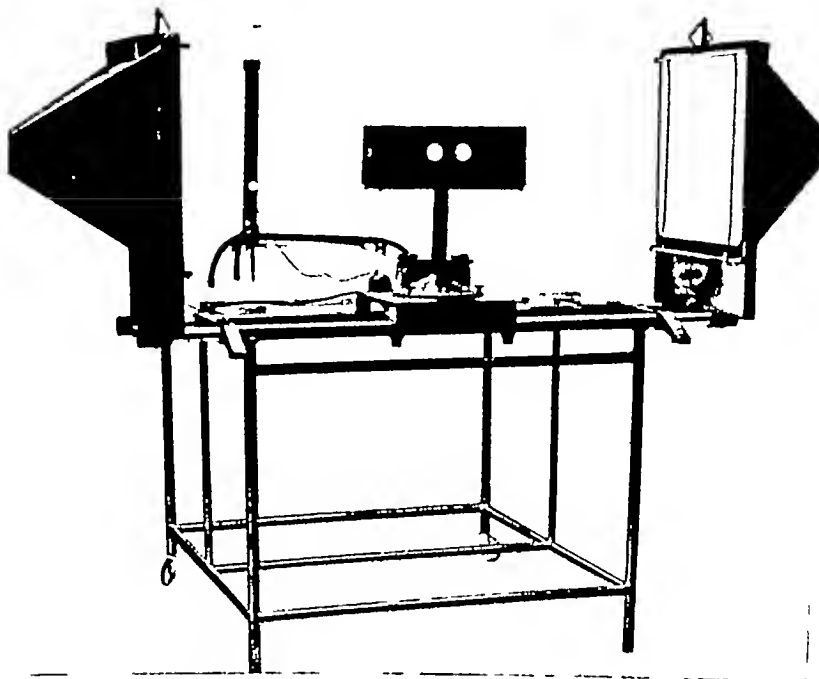


Fig 12-A Stereoskiosk of Hasselwander. Note marks of axial rays, and measuring device in rear

We shall first consider the conditions required for the production of a tautomorphic image, that is, of an image which accurately corresponds to the object in all angles and dimensions. For this, the following rules are specifically important

1 Observation should take place at a distance equal to that used during exposure (or *vice versa*)

2 The distance of the tube-shift should correspond to the pupillary distance of the observer (slight differences in the pupillary distances of different observers are of relatively little practical importance). In the case of determination of measurements the discrepancies produced by such differences can be calculated easily. The average shift

must be marked. In case other angles are used, the degree and plane of inclination must be noted, so that it may be reproduced during observation by proper angulation or inclination of the illuminated films. During observation of the films these marks must be arranged in such a way that the central ray from the eye of the observer falls at a right-angle to this mark. The fact that this ray is reflected in a mirror stereoscope does not change this condition, which is easily met by markers on the illuminated surfaces of the viewing apparatus. The marks of the axial rays on the films have then to be coincident with those on the illuminators. Even though the proper placement of the pictures is much facilitated, such markers are missing in most

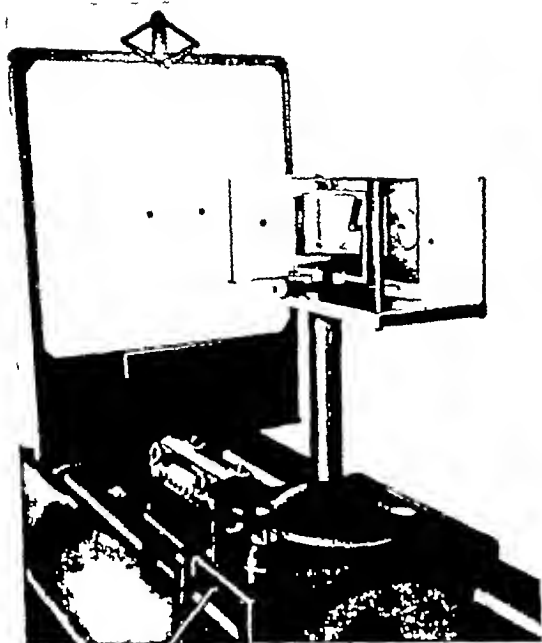


Fig 12-B Sighting device for axial rays in the Hasselwander stereoskiagraph

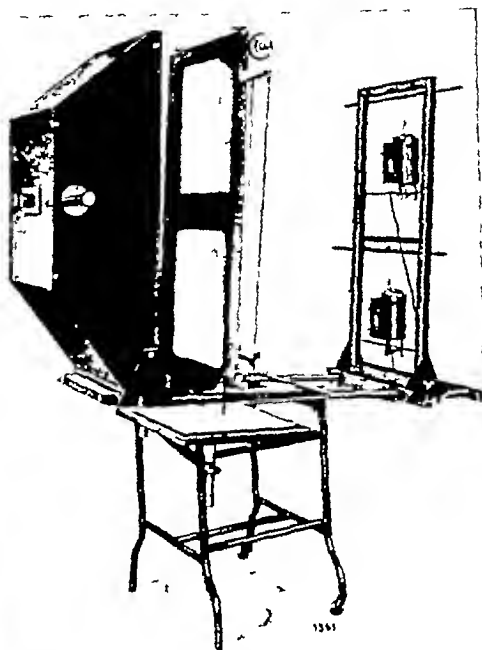


Fig 13 Beyerlen's stereo-orthodiagraph

viewing apparatus. Later on we will describe the stereoscope designed by Hasselwander which is equipped with such markers.

4 It must be noted on each film for which eye it is to be used in the viewing apparatus. That is, the film taken with the tube shifted to the left must be viewed with the left eye, the one taken with the tube shifted to the right must be viewed with the right eye.

5 Care must be taken that the films are observed in the same direction in which they were exposed. If, for instance, during a thorax exposure, the subject leans with his chest against the cassette, the film must be so adjusted that an impression is produced as if we were looking into the chest from behind (ortho-stereoscopic image). If we were to view the films reversed, the result would be a pseudo-stereoscopic image. We shall explain this later on. When a mirror-stereoscope is used, the films must be set up with reversed sides to compensate for the reversal produced by the mirror. This, however, holds true only for two-mirror stereo-

scopes like those suggested by Wheatstone. In the case of four-mirror stereoscopes, the reversal is, of course, corrected by the second reflection.

#### MOST FREQUENT AND IMPORTANT DISTORTIONS OF THE STEREOSCOPIC IMAGE

Frequently, x-ray workers do not know the meaning of the terms *ortho-* and *pseudo-stereoscopy*, nor do they realize the possibilities of distortion through inaccurate working. Anyone can get an idea of these conditions by making a cube of wire and obtaining stereoroentgenograms of it. In case of tautomorphic stereoscopy, the resulting image must again be a cube. Most persons would be considerably surprised to see quite different images produced whenever the conditions of exposure and observation mentioned above are not fulfilled. This leads to misconceptions which may be so misleading that absolutely mistaken relationships may be construed eventually in a human body.

The principal sources of errors will be explained by means of a few geometric figures

## 1—ORTHOSTEREOSCOPIC IMAGE

Figure 1 shows a square  $ABCD$  of which two images are produced by the lens( $es$ )  $C_1$  and  $C_2$ . These images, with the points

which are the corners of the original square. We can, therefore, also regard the images  $a_1d_1b_1c_1$  and  $a_2d_2b_2c_2$  as stereoscopic pictures. It is practically immaterial whether we base

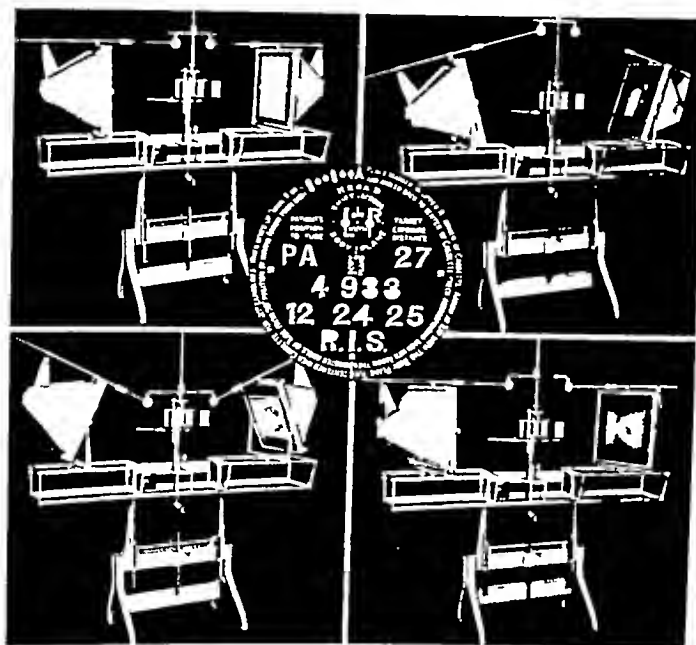


Fig 14 Reaves radiograph-scope. Note possibility of simultaneous angulation and inclination of illuminated film-carrying surfaces. Films are centered by self-adjusting double duplex curtains. The instrument has first surface mirrors, binocular lenses and chromatic illumination, but is not equipped with a measuring device. (Illustrations by courtesy of Radiograph-scope Co., successor to the Reaves Instrument Shop, Greensboro, N. C., U. S. A.)

indicated in the figure, may correspond either to a photographic plate or to the retina of the eye. If we draw straight lines from the corners of the square  $ABCD$  through the points  $C_1$  and  $C_2$  to the basic plane, we find the images  $c, b, d, a$  and  $c_2d_2b_2a_2$ . We now assume a semi-transparent glass plate placed at the same distance from  $C_1$  and  $C_2$  as the basic plane, but in front of these two points. Two images are then formed on this plate,  $adbc$  (left), and  $abdc$  (right). If we now connect the point  $C_1$  with the points  $a_1d_1b_1c_1$  and  $C_2$  with  $a_2d_2b_2c_2$ , the extensions of corresponding connecting lines will intersect in the points  $A, B, C, D$ ,

our observations on these stereoscopic pictures or on the images on the retina or on the photographic plate, respectively. In the following we have chosen the latter case for convenience. From now on, therefore, we shall reverse the procedure originally described and begin our line of reasoning on the basic plane.

## 2—PSEUDO-STEREOSCOPIC IMAGE

In Figure 2 the two individual images  $c_1b_1d_1a_1$  and  $c_2d_2b_2a_2$  have been exchanged, that is, the picture originally on the left has been moved to the right on the other. If we now connect the points  $c_2d_2b_2a_2$  with  $C_1$  and

extend these lines into the space beyond  $C_1$ , and if we do the same thing with the points  $c_1b_1d_1a_1$  and  $C_2$ , each two corresponding lines intersect in points  $A$ ,  $D$ ,  $C$ , and  $B$ . Connecting these points, we do not find a square but a rhomboid. The sides turned towards the refracting points  $C_1$  and  $C_2$  appear shortened, and those turned away appear elongated. We find further that, although point  $A$  is still on the left and  $C$  on the right, points  $D$  and  $B$  have exchanged their relative positions. A pseudo-stereoscopic image has been formed which does not any longer represent the same figure as that produced by the orthostereoscopic image. It has become flattened in front, extended towards the back, and it has also been distorted laterally.

### 3—THE PSEUDO-STEREOSCOPIC "MIRROR-SCRIPT" IMAGE

Another form of pseudo-stereoscopy may be produced in a different manner. It is possible to reverse each one of the individual images. In the case of photographic plates, we could turn the glass sides towards us instead of the emulsion sides. This case is shown in Figure 3. In the basic plane the picture originally on the left in Figure 1 is still on the left, and the other is still on the right, but each individual image is so turned that in the left picture the point  $a_1$  and in the other the point  $a_2$  is now on the left instead of on the right side. If we now again connect  $a_1d_1b_1c_1$  with  $C_1$  and extend these lines beyond  $C_1$ , they will intersect the corresponding extensions of  $a_2C_2$ ,  $b_2C_2$ ,  $d_2C_2$ ,  $c_2C_2$ , in the points  $C$ ,  $D$ ,  $A$ , and  $B$ . If we connect these points we find a similarly distorted figure as that in Figure 2, only, the image has been extended still farther backwards. In this image, furthermore,  $A$  is no more on the left but on the right side, while  $C$  is on the left instead of on the right. Again  $D$  has come forward and  $B$  has re-

ceded. The image is now a pseudo-stereoscopic "mirror-script" image.

### 4—THE SIMPLE "MIRROR-SCRIPT" IMAGE

There is also a possibility of producing a simple "mirror-script" image (Fig. 4). This takes place when the whole basic plane containing the two partial figures is reversed, so that again the glass takes the position of the emulsion, but so that at the same time the right figure is placed on the left and *vice versa*. This may also be produced by applying the two individual reversals of Figures 2 and 3 at the same time. In this manner the right individual image is placed on the left side of the basic plane, in such a manner that the points are arranged in the sequence  $a_2b_2d_2c_2$  while the original left partial figure is reversed to the right with the sequence  $a_1d_1b_1c_1$ . If we now connect these two groups of points with  $C_1$  and  $C_2$ , respectively, and extend these lines beyond  $C_1$  and  $C_2$ , the corresponding lines intersect in the points  $C$ ,  $B$ ,  $A$ , and  $D$ . As in the original figure,  $B$  is in front and  $D$  in the back, while  $C$  now is on the left, and  $A$  on the right. We have, therefore, produced a "mirror-script" stereoscopic image. Front and back are in their true relative position, but left and right have been reversed.

The illustrations given here demonstrate plainly the necessity of correct marking of the individual images during the exposure so that it is possible to place them correctly in the stereoscope, and to eliminate the possibility of confusion as to the relative or absolute position of the two films.

### 5—THE MODELING EFFECT

Changes in the image may be produced by still other means. First we should like to discuss the modeling effect. For this purpose we begin with Figure 5 in which a square similar to that in Figure 1 is shown. In Figure 6, the two individual images have

been separated so as to double their original distance in the basic plane. The distance between  $C_1$  and  $C_2$  has also been doubled. In the same manner the distance between the

$C_1$  and  $C_2$  the resulting image appears changed, it is the greater, the greater is the distance. The dimensions of the image are changed.

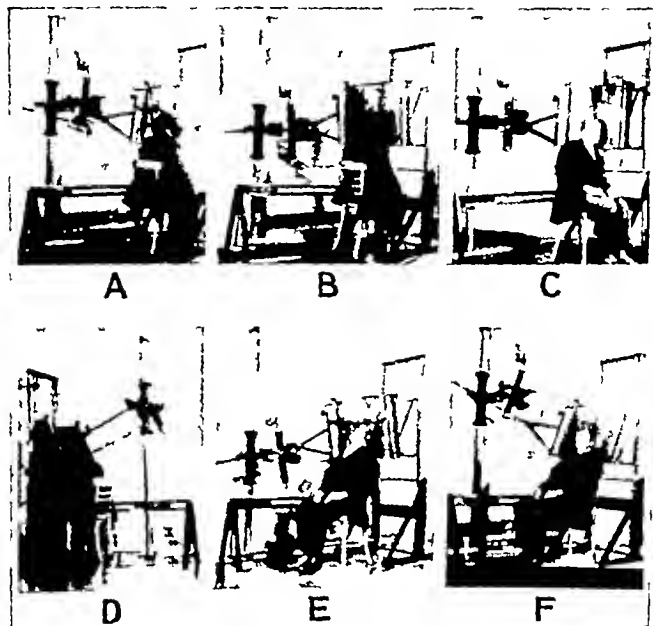


Fig 15 A Potter-Bucky diaphragm for use in erect position, especially for stereo-projection of the skull (Designed by Teschendorf, built by Siemens-Reiniger-Weifa, Berlin)

two stereo-pictures on the semi-transparent plane is double that found in Figure 5. If we now draw the respective connecting lines as in the previous figures, we again find the points of intersection  $A$ ,  $B$ ,  $C$ , and  $D$ . If we connect these points, we again have a square (Fig 6), this square, however, has four times the area of that shown in Figure 5. We can also imagine a reversal of this procedure, and we might reduce the distance between individual images and that between points  $C_1$  and  $C_2$  to one-half of the original distance. In this manner we would get a square with one-fourth of the original area (for example, going from Figure 6 to Figure 5). We find, therefore, that by changing the distance between the two focal points

However, if the shifts of the individual images and of the focal points are absolutely uniform, the resulting figure is always a square again. The assumption is in this case that the connecting lines drawn have the same angles to the basic plane as in the original figure. In this manner the image is changed only in dimensions but not in angles. This phenomenon is called the *model (ing) effect*.

#### 6—THE SIGNIFICANCE OF THE AXIAL RAYS

Something still different happens when the angles between the connecting lines and the basic plane are changed. For this consideration we erect two verticals on the br-

sic plane of Figure 7. The conditions are similar to those in former figures, except that the square has to be made smaller—by reason of the sizes of the reproductions,

This can be done with the axial rays marked. These axial rays correspond to the vertical drawn in Figure 7 from  $C_1$  and  $C_2$ , respectively, onto the basic plane. We see instant-

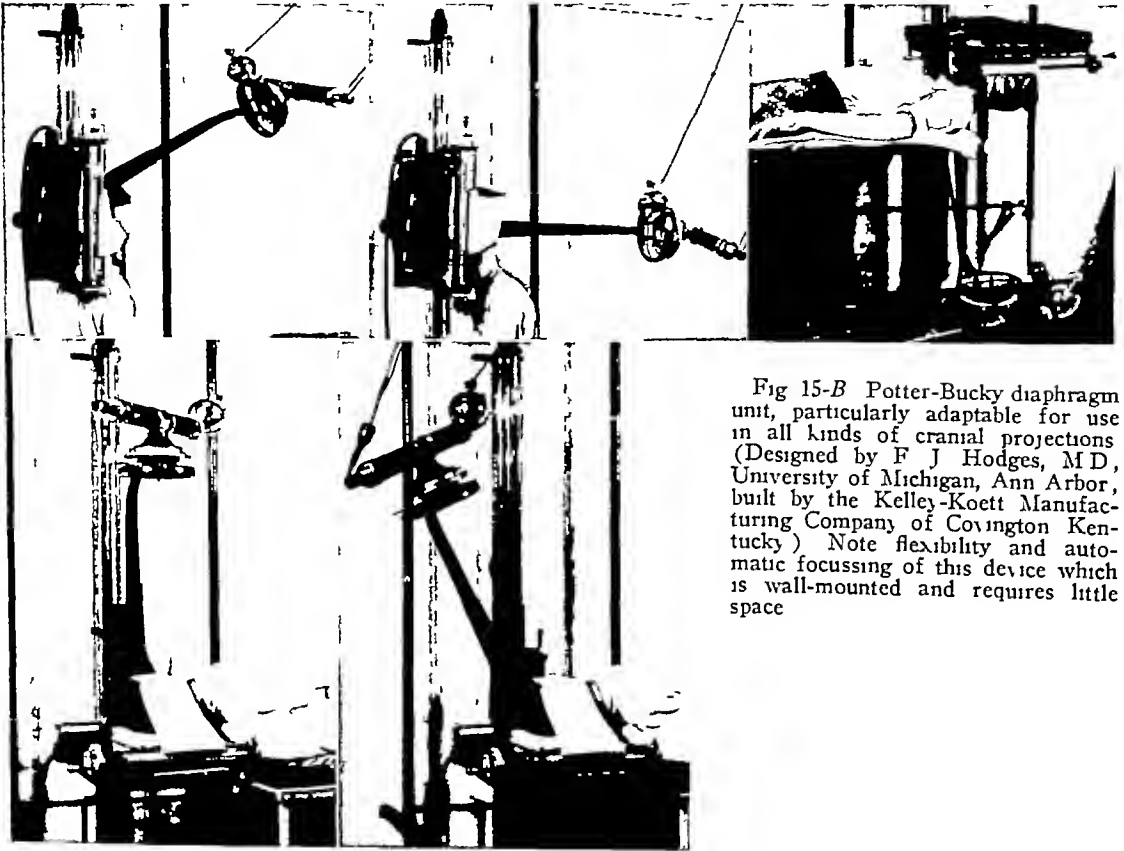


Fig 15-B Potter-Bucky diaphragm unit, particularly adaptable for use in all kinds of cranial projections (Designed by F. J. Hodges, M.D., University of Michigan, Ann Arbor, built by the Kelley-Koett Manufacturing Company of Covington Kentucky.) Note flexibility and automatic focussing of this device which is wall-mounted and requires little space.

which are not given in true proportion. Again we have the individual figures  $c_1b_1d_1a_1$  and  $c_2d_2b_2a_2$  in the basic plane. In the next, Figure 8, the distance between  $C_1$  and  $C_2$  is the same, but the basic length is reduced to nearly half of the original, or, in other words, the viewing angles for each film are reduced. Again, we draw the connecting lines as before. The resulting image shows great distortion and enlargement, being a quadrangle instead of a square, and appearing to be extended towards the front and even more towards the back.

This figure shows how important it is to maintain the same angles during the exposure of the films and during observation

ly that the axial rays have an entirely different direction in Figures 8 and 7 while they pass outside of the image in Figure 7, they run right through the image in Figure 8.

#### 7—TELESTEREOSCOPIC DISTORTION

Still another type of distortion is produced when the films are viewed at too short or too long a distance. For this purpose we compare Figure 9 (exactly like Figure 1) and Figure 10. In the latter the distances of the basic plane and of the semi-transparent screen to  $C_1$  and  $C_2$  have been reduced to one-half. Under such conditions we produce



a figure *ABCD* which appears at shorter distance than the original, and which has the shape of a transverse rhombus. The result of the reverse process is shown in Figure 11.

tation are not as simple as this author assumes. The figures demonstrate, however, that a true spatial representation cannot be produced under such circumstances if the films are viewed in an ordinary stereoscope.



Fig. 16 Stereo-views of optic foramen and petrous bone of same side.

We have drawn these figures especially because it is often assumed that it does not matter whether or not x-ray stereoscopic films are viewed from a distance different than that used during the exposure. The opinion is quite general that it is of no consequence when exposures are made at a great distance, with a long tube shift, and then examined at a shorter distance and with a narrower pupillary distance. A comparison of the figures shows, however, that distortions may easily appear in this case, in which the errors may be combinations of the different possibilities discussed above. The influence of these errors may be additive as well as subtractive, the latter if the tube shift is chosen in a certain proportion to the exposure distance. Diocles has suggested the proportion 1:10. For example, according to Diocles, films made at 80 cm distance should be taken with a tube shift of 8 cm, and for others taken at a distance of 120 cm the tube shift should be 12 centimeters. However, conditions for exact represen-

Roentgenograms of the human body, taken in this manner, do not appear as much distorted as might be concluded from the figures, because inaccuracies are not easily noticed in the curved surfaces of the body as long as no means of measuring are employed. Where it is necessary, however, to obtain accurate measured localization, it is important to choose exposure conditions in such a manner that they correspond accurately to the viewing conditions, so that a tautomorphic image is produced.

It is impossible to discuss all other errors which may enter into the production of stereoroentgenograms. One observed occasionally is that the film container for one exposure is not in the same plane as that for the other exposure, this also produces distortion.

#### VIEWING DEVICES

The lesson to be drawn from the above theoretical explanations is this: For an observer who has a pupillary distance of 66

cm, the stereoroentgenograms are to be taken with a tube shift of 66 centimeters. Besides, he must use a stereoscope in which the eye may be placed at the same distance

measurements by means of a luminous mark. In this instrument the two illuminated planes over which the films are fastened with spring clips are movable on two tracks so

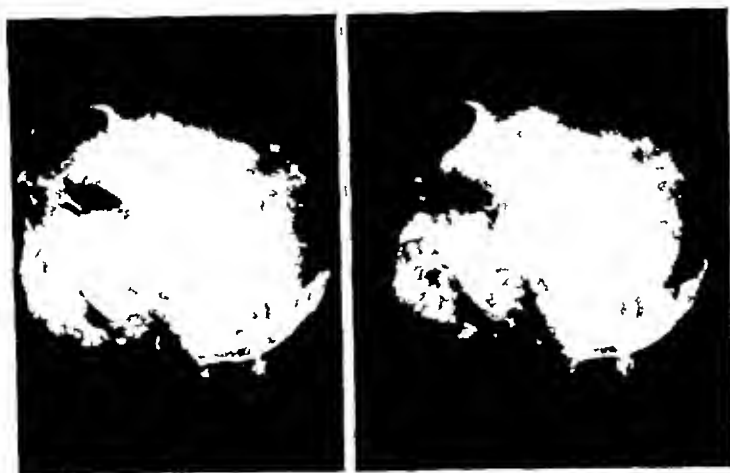


Fig 17 Oblique projection of the petrous bone and mastoid distant (not in contact) to film

from the film as the tube focus was from the film during exposure. If the stereoroentgenograms are taken with a Potter-Bucky diaphragm, exposure and viewing distance should be adapted to the radius of the particular diaphragm used. The stereoscopes most generally used to-day are based on the principle of the Wheatstone mirror stereoscope. Some have the disadvantage that the distance of the films from the mirrors is fixed, while it should be variable to allow for adjustment of the distance to that prevailing during exposures. Furthermore, most of these viewing instruments do not have any devices for the centering of the axial rays. Only when the central rays of our eyes or the axial rays fall at right-angles onto the films in the points marked during the exposure is it possible to produce a spatially correct image which can be measured. The "Stereoskiagraph" of Hasselwander (manufactured by Dr. Sendtner, of Munich) may serve as an example of a Wheatstone mirror stereoscope equipped for accurate observation and stereoscopic meas-

that they may be correctly adjusted to proper distance. The stereoscope is equipped with marks on the tracks for certain distances and a centering device by means of which one may check the proper distance. On the illuminated planes carrying the films two points are marked which must be coincident with the marks of the axial rays on the exposed films. In addition to this the apparatus is equipped with a sighting device which is used for proper alignment of eye and films, especially during measuring. Between the mirrors and the illuminated planes is placed a glass plate at the end of a box-like cover on which a small circle is marked through this the corresponding base point of the axial ray is sighted. If we look into the stereoscope, therefore, we adjust it first so that for each eye the corresponding axial ray point falls into the center of the circle. The image obtained is tautomorphic, provided the conditions during exposures were accurate. For measuring of the stereoscopic image, Hasselwander has constructed a small apparatus carrying a luminous point-

shaped mark. It is a small electric incandescent lamp, adjustable in height, of which only a point is uncovered, and which can be rolled on a special track. As the mirrors in

coscopic films unless special devices are used to compensate for distortion and bring long distances within reach of the arm.

With the stereo-orthodiagraph (Fig 13)



Fig 18. Acoustic meatus and mastoid—similar to a Law projection (gun-shot injury)

the Hasselwander apparatus are semi-transparent, the luminous point may be seen through them. Thus the stereoscopic image appears to the observer not at the ends of the apparatus but directly in front. The luminous index visible through the mirrors appears to be in the spatially visible image and can be moved around in this image at will to any point which may be of special interest. Vertically below the luminous mark is a pencil operated by a lever, with it, one can produce marks and drawings on paper. Any position of the luminous mark may, therefore, be recorded on a chart. In this manner whole cross-sections may be drawn through the body, traced and measured. With such equipment and under proper procedures it is possible to measure the stereoscopic image with an accuracy of 1 millimeter. Kohlme recently checked carefully on the accuracy of this method.

However, telestereoscopic films cannot be evaluated with the Hasselwander apparatus—the distance would be too great to be reached with the luminous mark. In general, it will be difficult to evaluate telester-

built by Beyerlen, an apparatus also used in Germany, it is possible to evaluate not only films which are seen tautomorphically, but also those which are seen homiomorphically, that is, incorrectly as far as spatial relations are concerned. In the present models of this device, however, the accuracy of the measurements does not completely approach that obtained with the Hasselwander apparatus, but because the apparatus deserves to awaken great interest on account of its principle, it is described briefly. This instrument makes possible spatially correct viewing with normal pupillary distance for exposure distances up to 1 meter. It also enables one to measure telestereoscopic films. The distortion eliminator is built on the following principle. The shadow of the measuring wire or of the measuring point (index) is projected onto the two individual images by two lamps. These two lamps throw cones of light onto the films corresponding to the cones of x-rays during the exposure, and under these conditions also show the shadow of the measuring index. The further the two lamps are moved apart, corresponding

to the tube shift, the further the shadows of the measuring wire separate on the two films. In this manner it is easy to produce the same parallax difference used during

the impression of a disc instead of a body. This is partly the result of its motion. In order to produce greatest accuracy, it is often desirable to use different equipment



Fig 19 Axial view of the cranial base (Metastasis of a carcinoma of the parotid may be noted in right base)

the exposures. It is further possible to measure stereoroentgenograms with this shadow without actually viewing the stereoscopic image. This is an advantage for persons who are not able or experienced to view stereoscopic images. Corresponding to the suggestion by Diocles and inasmuch as the stereo-orthodiagraph is independent of the pupillary distance, Beyerlen suggests the proportion 10:1 for exposure distance and tube shift (shift =  $1/10$  of the exposure-distance).

#### REMARKS CONCERNING SOME OF THE RADIOGRAPHIC APPARATUS

In many respects equipment should be adapted to the requirements stated. It is especially important in some instances to change films rapidly. If an organ moves in the interval between the two exposures, the resulting image will be spatially incorrect. Through the motion a pseudo-parallax may be produced which prevents a three-dimensional impression or simulates faulty shapes. For example, the heart often gives

for various purposes. For stereoscopic chest work, for instance, breathing between exposures is not permissible and each exposure preferably should be obtained at the same phase of the cardiac cycle.

For skull and sinus work one of us (Teschendorf) has designed a special Potter-Bucky diaphragm-unit which is similar to, but more limited than, the one built in the United States by the Kelley-Koett Co at the request of F. J. Hodges, M.D., Professor of Roentgenology at the University of Michigan, Ann Arbor (Figs 15 and 16). It will hardly be possible nor is it necessary to install special stereoscopic apparatus for all purposes in smaller departments, where most of the work can be done with simple home-made equipment. The ideal—obtaining both exposures simultaneously as attempted experimentally by various methods of "Raster" or grid-stereography—is not realized in practical roentgenology.

#### FURTHER TECHNICAL SUGGESTIONS

While generally stereoroentgenograms

are made in projections practically identical with plain single views, it can be demonstrated with certainty, however, that different principles of projection are more advantageous. Obviously, for instance, typical lateral views of the skull (and also of other parts) produce superimposition of symmetrical structures. We hope to eliminate by such projection quite a few sources of confusion and simplify the study of such records. In reality we are the victims of an illusion, which becomes quite apparent when we try to decipher stereograms, obtained in the same manner, we have difficulties in visual separation of the superimposed shadows of the two symmetrical sides and cannot obtain reliable information concerning the basal fossæ of the skull. While striving for elimination of confusing complexity, we limit greatly the possibilities of information and defeat the purpose of stereoscopy. Spatial visualization improves with increasing number of delineating lines, planes, and distinguishable points. Therefore, one should digress from time-honored routine procedure and systematically employ oblique projections which prevent superimposition and, instead, separate corresponding symmetrical structures onto different parts of our films. Thus, spatial conception and evaluation become much superior. This principle of oblique projection may be applied in two ways, one may tilt the objects in suitable manner and maintain rectangular relationship between beam and film, realizing also the possibility of limited longitudinal or lateral shifting of the axial ray to produce advantageous projections of particular planes, or one may employ certain well defined angles of inclination of beam to films, thus again striking the objects obliquely. This latter method lately has been emphasized again by Koch and Koehnle, in Cologne, Germany, but it should be remembered that its value was recognized by Reaves with the construction of the Reaves "radiographi-

scope," which permits of easy reproduction of any kind of angulation and inclination used for correct viewing of stereoroentgenograms secured in any manner. (With the use of this method, inclination and angles should be noted distinctly on the films, so that they may be reconstructed properly for viewing purposes without distortion. The Reaves universal marker is the best designed for these purposes.) One of us (Teschendorf) has made a special study of such oblique stereo-projections of the skull and published his suggestions in 1930 in *Fortschritte auf dem Gebiete der Roentgenstrahlen*, XLI, 17. These projections generally follow those worked out by various authors (especially Schueller) for detailed study of individual cranial parts, and a few examples are reproduced in stereoscopic views with accompanying technic.

The desirability of stereoscopic study of the chest is well recognized. However, the tendency of late years has been towards very soft roentgenograms, showing a confusing, complex wealth of soft-tissue detail. Of course, with diminishing potential the layers of the chest participating actually in the production of the image retract more and more towards the surface close to the film, while those more distant are recorded with diminishing certainty. It has to be admitted, therefore, that the ideal quality of a chest film is the result of a compromise, neither the very hard film nor the very soft one is desirable. As a good criterion one may use the faint visibility of the carina through the upper thoracic spine, while the lower dorsal spine should not be distinguishable through the heart shadow. Whenever expenses may be disregarded one obtains most correct information from stereo-projections in anteroposterior and postero-anterior directions, otherwise it is preferable at times particularly with heavy patients of considerable diameter to omit stereo-projections in favor of single anteroposterior

or postero-anterior views, eventually supplemented by a lateral exposure. Improvement in tubes, permitting of the use of greater energy and longer distances, may help to overcome such difficulties to a certain extent

to the rather unphysiologic distention of the gut

#### CONCLUSIONS

- 1 Characteristic differences between



Fig 20 Calcifying pleurisy

Stereo-projections of stomach and colon may prove to be of increasing importance in the future. With small amounts of contrast medium the stomach will often remain quiescent for a period sufficiently long to produce stereo-images, such views of its mucosal structure are quite fascinating. It is necessary then to secure an opaque coating adherent to the entire circumference of the gastric mucosa and not merely sedimentation in the dependent portions. In this connection experimentation with colloidal substances<sup>3</sup> are quite promising and of great interest. In the colon we have repeatedly observed quiescence over prolonged periods following injection with contrast medium and succeeding inflation (method of A. W. Fischer). During such periods stereoroentgenograms of impressive quality may be obtained. Fischer's method so far has not obtained great popularity in America, and, while recognizing its superiority, one should at the same time emphasize its fallacies due

photo- and roentgen-stereoscopy are briefly reviewed.

- 2 Technical necessities for correct roentgen-stereoscopy are summarized.

- 3 Ortho- and pseudo-roentgen-stereoscopy, the simple and pseudo-stereoscopic mirror image, the "modeling" effect, tele-stereoscopic distortions, etc., are explained diagrammatically.

- 4 Viewing devices are discussed, with emphasis on the Hasselwander stereoskopograph and the Reaves radiograph-scope, which, if combined, would form an ideal instrument. Some technical suggestions are offered.

Quotations from the literature are omitted. They are recorded excellently in *Lehrbuch der Roentgenstereoskopie*, by Dr. Max Cohn and Dr. Walter Barth, published in 1931 by Georg Thieme, Leipzig.

The authors acknowledge with sincerest appreciation the aid of the Department of Research of the Detroit Edison Company during the preparation of this paper.

<sup>3</sup>As initiated by Blumbaum, Frick and Kalkbrenner (see *Fortschr. a. d. Geb. d. Roentgenstrahlen* 1928 XXXVII 18) also subsequent publications.

## PRIORITY IN THE THERAPEUTIC USE OF X-RAYS

By EMIL H GRUBBL, B S, M D, CHICAGO

**I**N order that the history of x-rays may properly record events in the order in which they occurred, and also for the purpose of giving credit where credit is due, I submit the following brief

Recently, while looking through some boxes which contained records of the happenings of many years ago, I discovered several references (which I thought had long been destroyed by fire) pertaining to my own early work in the x-ray field. Under the light of this newly found material, I feel that the claims, which have been made for others, to priority in the therapeutic use of x-rays, should no longer go unchallenged by me.

In other words, when my records are compared with all the available records of others in this field, I am convinced that the way will have been opened for me to make the following claims:

First, that I was the first person exposed to x-rays who received sufficient cumulative effects to develop x-ray dermatitis.

Second, that I was the first person to apply x-rays to pathologic lesions on living human subjects for therapeutic purposes.

Third, that I was the first to use sheet lead, or, for that matter, any other substance, as a protective against untoward x-ray effects.

The evidence which I am able to bring out of the seclusion of nearly thirty-nine years, and which constitutes the bases of my claims, comprises—

First, a business card of mine of the year 1895, which shows that, at the time the discovery of the x-ray was announced, I was a manufacturer of vacuum tubes, and

Second, two introductory letters, written by the two physicians who sent the first two patients to me for x-ray treatment.

Although I have had frequent occasions

to refer to this pioneering effort of mine (having been, from the beginning, a teacher of roentgenology and also having written many monographs dealing practically with all the different phases of x-ray work), I am frank when I state that I never have made a campaign to have my claims to priority in the therapeutic use of x-rays officially, as it were, accepted.

I must state in passing that, at the time I did this work, I could not realize the importance of the subject, nor how involved with controversy it would become in later years. As mentioned before, I believed that all written evidence bearing upon this issue had been destroyed by fire. This, together with the fact that, with the exception of myself, all those directly connected with this event had died before this subject had reached the controversial stage, would make it doubly difficult, if not impossible, for me to substantiate my claims. I felt that circumstances were against me and, without the evidence which I now have in my possession, the channels of credit were closed to me, and that I could not, therefore, expect support for my claims.

But now, after nearly four decades of waiting, I am in a position to assert my claims for recognition in this particular field, and, I hope, to receive the credit, which, I feel, should have been mine all these years.

To briefly review matters, during the latter part of October, 1895, Prof. William Roentgen began the serious study of cathode rays. While duplicating some experiments of Prof. P. Lenard (also of Germany), relative to fluorescence produced in chemicals when exposed to the cathode ray, Roentgen discovered that barium-platinum-cyanide crystals fluoresced with the greatest volume

of light He also found, as Lenard had discovered, that light-sensitive chemicals, such as photographic papers and plates, were affected by exposure to the rays which emanated from the vacuum tube On November 8, 1895, Roentgen wrote the first announcement of this work to the Physical Institute of the University of Wurtzburg, Germany His next, and most startling, announcement, was made before the Physio-medical Society of Wurtzburg, on December 28th of the same year

Incidentally, I might say that, to scientists who had been working with vacuum phenomena, the discovery of Roentgen was not nearly so startling as it was to the layman Many commentators on this subject state that the discovery of Roentgen burst upon the world without the least warning This may have appeared so to the general public, but so far as pure science was concerned, it was positively not so

In order that the subject, as a whole, may be more clearly understood, it seems to me that a brief account of the work which led up to Roentgen's discovery may not be out of order

We must go back to the year 1859, when Plucker, of Germany, first recorded the fact that after a vacuum tube had been frequently excited with high voltage current, an apple-green fluorescence was observable on the inner wall of the tube

In the year 1860, Prof Hittorf showed that the luminous stream in an electrically excited vacuum tube could be deflected by a magnet

In 1875, Sir William Crookes made his first high vacuum tube and discovered that the apple-green light of Plucker had its origin at the negative end of the tube Crookes therefore called this phenomenon the cathode ray

Crookes in 1879 was the first to suggest the concave shape of the cathode electrode, in order that it might bring the cathode

stream to a focus Somehow, no practical use of this idea was made until 1893, when Prof Herbert Jackson revived it by placing the anode of the tube in such a position that it would catch the cathode stream where the rays came to a focal point.

In 1894 Jackson added to this improvement, by placing the anode at an angle of about sixty degrees, in order to reflect the cathode rays out of the tube

In the latter part of 1892 and early in 1893, Prof H Hertz discovered that cathode (?) rays would pass through cloth, paper, wood, gold foil, and thin aluminum sheets when these substances were placed in the path of the rays

In December, 1893, Prof P Lenard made a Crookes tube with a window of aluminum in it Through this window he conveyed the cathode (?) rays out of the vacuum of the tube into the air Also, in August, 1895, he listed a number of substances capable of fluorescing when placed in the path of the cathode (?) rays In September, 1895, he reported that he had sent the cathode (?) rays through his own hand, and even then (after passing through his hand) these rays excited chemicals to fluorescence Also, in October, 1895, he reported that he had observed that light-sensitive chemicals, *i.e.*, photographic materials, were affected by exposure to cathode (?) rays

From the foregoing we will have to conclude that Lenard was really working with x-rays most of the years 1894 and 1895, but, of course, he did not know that We will also have to conclude that every experimenter who sent a high tension current through a Crookes tube, obtained not only cathode rays, but also x-rays

Roentgen, in duplicating Lenard's experiments, did something which the latter had not done First, he covered the Crookes tube with a cardboard box, next he darkened the room in which the experiment was performed, then he sent the electric cur-



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not have a large output of x-ray energy I judged that this was due to the fact that the cathode rays in my tubes were not concentrated sufficiently to transform them into effective x-ray value. Then I recalled having read that Jackson had in the two previous years improved the Crookes tube by decidedly cup-shaping the cathode. With this improvement the cathode stream could be brought to a focus. Also, in order to prevent the enormously high temperature which was generated where this focal area occurred, from melting or puncturing the glass wall of the tube, an anode of platinum was placed in such a position that it would intercept the cathode rays, thus keeping the heat from the glass, in addition, this anode was placed at an angle of sixty degrees in order that it might reflect the cathode rays out of the tube. Theoretically, this offered a decided improvement over the old-style Crookes tube. I immediately made a tube embodying the ideas of Jackson. The very first tube I made after this pattern was much more efficient than any I had tried before, and so, thereafter, I used only this type of Crookes tube for all my work.

Undoubtedly it was because of my early use of this method of focusing or concentration of the cathode ray on the anode of the tube that I developed x-ray dermatitis very shortly.

Incidentally, it must be remembered that, having worked with Crookes tubes in the study of fluorescence before December 28, 1895, my body had been exposed to x-rays some time before Roentgen made his announcement.

I made a number of tubes, all of which I tested for vacuum by exposing my left hand between the tubes and fluorescent materials. This was done many times daily for many days. In other words, my left hand was practically touching the excited Crookes tubes during most of the testing periods. These frequent and long exposures to the x-ray produced a cumulative effect, so that,

by the beginning of the last week of January, 1896, I had developed a dermatitis on the back of my left hand, which was so acute that I sought medical aid.

At first my symptoms were erythema, edema, hyperemia, and hyperesthesia. A few days later there was bleb and blister formation, with skin desquamation and epilation of the hair. Later the skin cracked and ulcers formed. (Parenthetically I would state that this hand was amputated piecemeal, and for some years has been gone entirely.)

On January 27, 1896, I consulted my attending physician, Dr J P Cobb, in the faculty room of the Hahnemann Medical College (which later became the General Medical College). Dr Cobb was a professor, and I an undergraduate medical student, in this institution. While Dr Cobb was examining my hand, Dr J E Gilman, Dr A C Halphide, and Dr R Ludlam, all of them professors in the college, entered the room. My ailment being a new one, Dr Cobb used me as a clinical subject. He explained my symptoms, also the cause, and asked for advice. Each of the doctors present, except Dr Gilman, offered remedial suggestions. Dr Gilman, after thinking over the origin of the dermatitis, said that although he would not offer a remedy for the trouble he thought that "any physical agent capable of doing so much damage to normal cells and tissues might offer possibilities, if used as a therapeutic agent, in the treatment of pathologic conditions in which pronounced irritative, blistering, or even destructive effects might be desirable." As examples of such lesions he mentioned cancer, lupus, and indolent ulcer.

This statement of Dr Gilman's made a profound impression upon all those present, Dr Ludlam and Dr Halphide being especially impressed. Both were anxious to know what would happen if pathologic tissues could be exposed to x-rays long enough to get a cumulative effect. Dr Ludlam said

rent through the tube, and finally, he placed his hand between the fluorescent chemical and the Crookes tube, and when the crystals of barium-platinum-cyanide began to glow, he saw the shadow outlines of the bones of his hand

All whose names I have mentioned in the preceding paragraphs, and many others, including myself, who had experimented with high vacuum tubes undoubtedly had x-rays every time the "apple-green light" of Plucker was present in their electrically excited Crookes tubes

The point I am trying to make is, that x-rays were in existence before Roentgen discovered them. Yes, we really had x-rays in the year 1859—thirty-six years before Roentgen announced the finding of them. So it must be evident that, to those conversant with vacuum phenomena, the discovery of Roentgen was not so startling after all. The truth is, that the labors of Lenard had prepared them to expect just about what Roentgen found. On January 4, 1896, Roentgen went to Berlin and again presented his paper. Following this lecture the public press heralded his discovery to all the world.

At the very time when Roentgen did this work I also was working with Crookes tubes, studying the fluorescence of chemicals. I had read in "Annalen der Physik und Chemie," of September and October, 1895, of the experiments of Lenard, and I was duplicating this work when the discovery of x-rays was announced by Roentgen. Under the stimulus of this new discovery I worked almost continuously for several days, duplicating Roentgen's experiments and making new Crookes tubes. I was, in all probability, one of the earliest experimenters with the new rays. The subject was of particular interest to me because, at that time, I was not only an experimenter with vacuum tubes but also a manufacturer of these devices. My business card of that period read

E. H. GRUBBE  
Assayer and Refiner of Rare Metals  
Manufacturer of  
Incandescent Lamps, Geissler and Crookes Tubes  
12 Pacific Avenue Chicago

Naturally, then, my interest in and appreciation of Roentgen's discovery were pronounced. I should also state that I was one of the very few who had available all the apparatus needed to duplicate the experiments which led up to the discovery of x-rays. I did not have to go out and purchase or have made any part of the equipment. With the exception of photographic plates, I had everything—Crookes tubes, induction coil, electric current generators, fluorescent chemicals—right at hand. Not only that, but, being a chemist and physicist, I was one of the few who had technical knowledge sufficient to appreciate the importance of this discovery. Then, too, I needed no one to teach me the use of these devices.

For the purpose of exciting my home-made Crookes tubes I used the secondary current of a home-made Ruhmkorff induction coil. It is interesting to note here that I also used a home-made static generator as an exciter. However I found this machine too lacking in current output, when compared with the induction coil. Nevertheless, at the beginning of April, 1896, in conjunction with C. S. Neiswanger, I did considerable research work with larger static generators, at the factory of the McIntosh Battery and Optical Company of Chicago. These larger machines were found quite capable of exciting the Crookes tubes for practical purposes.

As a manufacturer of vacuum tubes I made it a point to know what others were doing in this line. I was of course, familiar with the research which had been carried on in the vacuum field by such men as Geissler, Sprengel, Toepler, Nobel, Shentone, Silvanus Thompson, Weinhold and Kahlbrum.

The first Crookes tubes I worked with did

fancied that I was not in a technical position to obtain credit

In this connection I contend that merely because my work was not written up in newspapers or medical journals, that fact alone should not exclude me from eligibility for credit. All things that have ever happened in the universe are not necessarily recorded in print. And so, I believe, the recording of an event in a book should not constitute the sole test of validity.

These early treatments with the  $\gamma$ -ray were given in a factory—obviously not a good place to serve sick persons. By the end of February, 1896, I had decided to open a properly equipped laboratory for the diagnostic and therapeutic use of  $\gamma$ -rays and electric currents. Accordingly, on April 1, 1896, I opened such a laboratory at 2614 Cottage Grove Avenue in Chicago, where I remained for several years.

Now, in order to place the dates of my work in juxtaposition with the historical facts about others for whom claims to priority in x-ray therapeutics have been made, I offer the following:

On January 29, 1896, Dr. T. G. Lyon, of London, wrote a letter to "The Lancet" in which he asked the question "Do  $\gamma$ -rays possess germicidal power?"

On February 4, 1896, there appeared in "Munchener medicinische Wochenschrift," an article by Dr. F. Mink, pertaining to the exposure of bacteria in culture media to  $\gamma$ -rays, with negative results.

In September, 1896, Dr. W. J. Morton, of New York, published a book on  $\gamma$ -rays, in which he asserted that he had, during February of that year, *i. e.*, 1896, exposed various bacteria in culture media to  $\gamma$ -rays. He found no bactericidal quality in the  $\gamma$ -ray.

On February 10, 1896, Thomas Edison stated in the newspapers:

"Now if they ( $\gamma$ -rays) can decompose certain chemicals after they have passed through solid substances why may they not have the same effect upon the bacilli and bacteria in the

body? I somehow feel that the roentgen rays will reach hydrophobia cases and perhaps effect marvelous cures. Then, again, look at the cases of consumption. Why may not these rays bombard the death-dealing bacilli in the lungs and give them an electro-static quietus?"

On April 10, 1896, in an article which appeared in "Science," Prof. J. Daniel, of Vanderbilt University, wrote that he had exposed the head of Dr. W. C. Dudley for the purpose of making a radiographic test, following which the latter's hair fell out from the side of the head which had been nearest the tube.

In a paper which was read before the Roentgen Society of England, on January 11, 1898, William Webster stated that he first noted therapeutic qualities in the x-ray when, during the latter part of April, 1896, he exposed the elbow joint of a patient repeatedly for the purpose of diagnosis, and found that rheumatic pains, which constituted the principal symptom in the case, were relieved.

In some books dealing with  $\gamma$ -rays, Dr. L. Freund, of Vienna, is given credit for being the first to make therapeutic use of these rays. To controvert this claim I need only state that it was not until the Fall of 1896 that Dr. Freund observed the loss of hair in a patient who had been repeatedly exposed to  $\gamma$ -rays, and who consulted him for  $\gamma$ -ray dermatitis. From that time on, Dr. Freund used  $\gamma$ -rays to remove superfluous hair, before that he knew nothing of the therapeutic qualities of these rays.

I have before me a copy of a paper which was read before the Roentgen Society of the United States on September 11, 1901, by Dr. H. P. Pratt, of Chicago, in which he stated the following:

"I will now give a brief review of my own work in this field. On the morning of the seventh of February, 1896, I saw the first account of Prof. Roentgen's work. In the

that he had a patient with an open inoperable carcinoma of the left breast, in which there was not only glandular involvement, but also systemic carcinosis. Evidently, this patient was doomed to early death, but he thought the case a good one on which to make a clinical application of Dr. Gilman's idea. If agreeable to me, he would advise this patient to come to me for x-ray treatment. Surely, the treatment could not make her condition more serious, on the other hand, it might be of some benefit. I agreed to accept this patient, if she cared to come for the new treatment.

Dr. Halphide mentioned that he too had a patient who might be induced to try the x-ray treatment. The case was that of a man who had ulcerative lupus vulgaris involving the entire right cheek and extending down into the right side of the neck. I agreed to accept this case also, for x-ray treatment.

On January 29, 1896, Dr. Ludlam's patient arrived at my place of business with the following note:

E. H. Grubbé  
12 Pacific Avenue

Dear Sir,

This will introduce Mrs. Rose Lee, who has carcinoma of the left breast.

She is willing to have you make x-ray applications.

I hope you can help her.

Yours truly,  
R. Ludlam, M.D.

January 28, 1896

And so, without the blaring of trumpets or the beating of drums, x-ray therapy was born. The very first application of the x-ray for therapeutic purposes was made upon Mrs. Rose Lee's cancerous left breast, by myself. This occurred on January 29, 1896, in Chicago.

The next day, January 30, 1896, Dr. Halphide's patient with lupus vulgaris came to me with a note which read:

E. H. Grubbé  
12 Pacific Avenue

Chicago Jan 29/96

My dear Sir,

The bearer, Mr. A. Carr, is the patient of whom

I spoke the other day. He has had lupus for twelve years. He will come for x-ray treatments as often as you think necessary.

Yours truly,  
Dr. A. C. Halphide

Of course, I had no preconceived technique or method of treatment to use on these two patients, the first to receive x-rays therapeutically. In each case I placed the Crookes tube almost in contact with the lesion. I gave each patient an exposure of about one hour a day. Remembering my dermatitis, I protected the healthy parts of the patient's body, adjacent to the pathologic area, with sheet lead taken from Chinese tea chests.

I believe that this was the first time that sheet lead, or any other substance, was used as a protective against untoward x-ray effects.

Little did I realize, at the time I gave Mrs. Lee her first x-ray treatment, that I was blazing a new trail in the therapeutic field, little did I realize that this was the beginning of a new epoch in the history of medicine.

In spite of the long period of time that has elapsed since my first introduction to this subject, I can recall very vividly the effect which the treating of these, my first patients, had upon me. They were not reported clinically by the physicians who sent them to me for the reason that both patients died within a month after commencing treatment, and before sufficient cumulative effects had been produced to warrant conclusions as to the value of the new therapeutic agent. Mrs. Lee died of systemic carcinosis. Mr. Carr fell on the street, sustaining a fracture of the skull which ultimately caused his death.

Perhaps you ask why I did not myself make a written report of these treatments. The answer is: Even though I did this now considered important work I could not, at the time demand the credit which I felt was due me for two reasons. First, I was not a graduate physician. Second, I did not have access to the medical journals. I therefore

curs on the inner and posterior aspect of the second portion of the duodenum, on the concave mesenteric border of the intestine, where a weakness in the muscular wall may be present. True diverticula are most com-

mon on the convex or outer aspect, but they may also occur on the inner side as well. The mobile portions of the duodenum are the most frequent sites of diverticula, the less mobile are not so commonly involved.

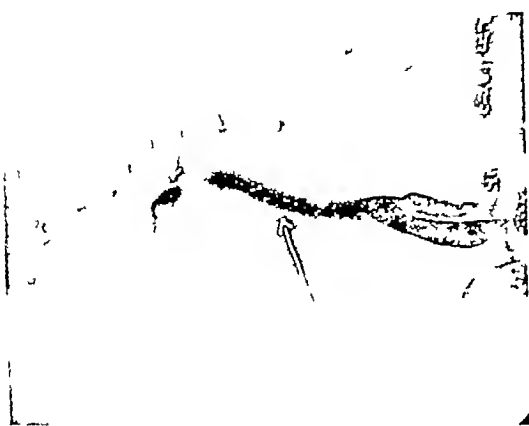


Fig 1 Anatomic specimen: the common bile duct and ampulla, dissected and filled with lipiodol.

mon on the convex or outer aspect, but they may also occur on the inner side as well. The mobile portions of the duodenum are the most frequent sites of diverticula, the less mobile are not so commonly involved.

The ampulla of Vater, a small, fusiform dilatation, about 5 mm in size, is formed by the entrance of the common and pancreatic ducts into the duodenum. Its orifice is but from 1 to 2 mm in diameter, and is surrounded by folds of mucous membrane, with a miniature sphincter (Oddi) made up of muscular fibers. According to Opie (3) the ampulla varies from 1 to 11 mm in length, the orifice averaging from 2 to 5 millimeters. More recently, Mann and Giordano (4) have demonstrated that the two ducts entered the ampulla together in 20 per cent of 200 cases.

Under normal conditions the ampulla of Vater cannot be filled with the barium meal during the usual roentgenologic investigation of the gastro-intestinal tract, but, under certain conditions dilatation of the sphincter may occur leading to a patency of the

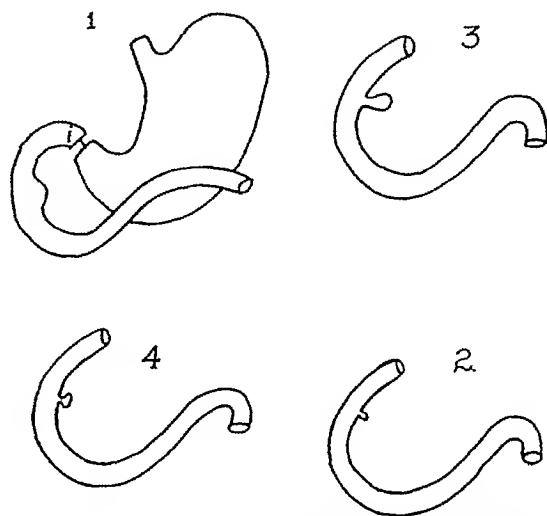


Fig 2 (1), a small depression in the ampullar area noted in a cadaver, (2, 3, and 4), tracings made from three cases.

hiatus, which may allow a return flow of the opaque meal. Cheever (5) states that the physical structure of the papilla itself is apparently designed to prevent regurgitation into the duct. Its lumen, which is extremely narrow, passes through a small conical elevation in the wall of the bowel, composed in part of smooth muscle fibers, the sphincteric action of which was first described by Oddi. The fibers apparently effectively close the orifice, except in cases in which the muscle tonus is inhibited or overcome to permit the passage of bile and pancreatic juice.

Roentgenologically the filled ampulla may vary from the size of a pea to that of a walnut—at times it may even become larger. The mouth of the pouch varies in size, but it is usually large, allowing the opaque meal to flow in and out freely. This type does not as a rule present a retention, unless inflammatory changes are present. Retention was observed in five instances in our series. In one, it resulted indirectly, occurring in a case of duodenal obstruction. These diverticula are freely movable with the duodenum and in all instances of our

first part of April, 1896, with the kind assistance of Prof Hugo Wightman, I succeeded in destroying the bacilli of eight different diseases, in culture tubes. Immediately after destroying the above cultures, thereby demonstrating the therapeutic value of the ray, I commenced to use it as a therapeutic agent, and on April 13, 1896, I placed my first cancer patient under treatment."

I have quoted Dr Pratt's paper at length in order to show that at the time when I was actually using x-rays in the treatment of cancer and lupus, *ie*, January 28-29, 1896, he (Dr Pratt) had not yet heard of Roentgen's discovery of x-rays. I wish to point out also that Dr Pratt states in this paper that he did not give his first x-ray treatment until April 13, 1896. In other words, Dr Pratt did not actually make use of x-rays in a therapeutic way until *more than ten weeks after* I had made such applications.

Now, if time is the essence in this controversy, then I call on the calendar to place the credit where it belongs. I have gone into

the highways and byways looking for information on this point, but I have found nothing which antedates my work in this field. And so, in view of all the foregoing, it would appear that in the therapeutic use of x-rays my work of January 28, 1896, preceded that of all others. Therefore, I feel that I have more than a just claim to whatever honor may be attached to this particular phase of x-ray pioneering.

In conclusion, I also think I am justified in giving Dr J E Gilman, of Chicago, credit for being the first to suggest that x-rays be used in a therapeutic way.

Summing up the evidence which I have submitted, I claim that it allows me to ask credit for being (1) the first human being exposed to x-rays sufficiently to develop x-ray dermatitis, (2) the first person to apply x-rays to pathologic lesions on living human subjects for therapeutic purposes, (3) the first to use sheet lead, or any other substance, as a protective against untoward x-ray effects.

## THE ROENTGENOLOGIC SIGNIFICANCE OF THE FILLING OF THE AMPULLA OF VATER<sup>1</sup>

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**D**IVERTICULA of the duodenum which have been recorded with increasing frequency in recent years, are now by no means an unusual finding in the routine roentgen-ray gastro-intestinal examination. To the clinician and roentgenologist, they are of considerable interest, due especially to their relation to the ampulla of Vater. The most frequent forms of duodenal diverticula are the congenital types occurring usually in the second portion, though they may appear in other parts of the duodenum. The most common type of congenital diverticulum is usually ob-

served in the region of the ampulla of Vater, ordinarily within a radius of 1 cm of the ampulla. A shallow depression at the ampulla is not an uncommon finding, and, when the diverticulum is in this form, the roentgen ray reveals a bulge, which may simulate a filled ampulla. This was observed in one instance by us in the human cadaver. Nagai (1) cites a case which at autopsy presented a similar depression into which a true diverticulum opened. Bassett (2) likewise records an instance in which a diverticulum opened into the ampulla.

Duodenal diverticula may be single or multiple. However the type involving the ampulla of Vater is usually single and oc-

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

odenum According to Duval, Roux, and B  cl  re, the possibility of differentiating between an ampulla of Vater and a true diverticulum, or an ulcer crater, rests upon two principal points (1) The exact site, that is, at the middle half of the internal border of the second portion of the duodenum, and (2) an absence of all clinical signs of active ulceration, thereby eliminating the question of an accessory pocket of an ulcer

All authorities call attention to the relative frequency of duodenal diverticula in the second portion, a location closely related to the ampulla of Vater, however, but little is recorded as to the actual filling of the ampulla and its clinical significance

In our study, there were 34 cases in which the filling of the ampulla had been observed, a finding noted during the usual roentgenologic examination of the gastro-intestinal tract which followed the barium meal No unusual technic was employed, though especial attention was always directed to the duodenal area In this investigation, the fluoroscopic examination is most important, involving the manipulation of the duodenum with the gloved hand, under direct visualization, as is essential in order to bring the ampullar area into view The latter is frequently overshadowed by the stomach, and may not be observed on the films Abnormal position of the duodenum may also interfere with the visualization On the other hand, during the examination of the duodenum, a lateral or oblique view will frequently reveal this otherwise obscure condition

In our series, associated with the filled ampulla of Vater the roentgen examination revealed 18 instances of right upper quadrant adhesions five of duodenal adhesions, three of duodenal stasis and one of duodenal obstruction Ulcers were noted in eight instances two in the esophagus two gastric, and four duodenal There was evidence in three instances of mucous colitis and in two of spastic colitis In six cases



Fig 5 Note large shadow at arrows on inner aspect of duodenum, due to a filled ampulla

in which cholecystographic examinations were made, five revealed abnormal findings

The fact that but 34 instances of the filling of the ampulla were observed in many thousands of x-ray examinations indicates the rarity of the condition

The following table presents our cases, arranged according to sex and age

Ages	Females	Males
20-30	2	1
30-40	5	2
40-50	5	3
50-60	7	3
60-70	4	2
Total	23	11

All of our cases presented dyspeptic symptoms of some form Pain occurred in the right upper quadrant of the abdomen in 23 patients, 15 of whom gave a history of acute attacks of biliary colic In three of these cases, jaundice had been observed In seven instances, pain (relieved by food) of the ulcer type was present, occurring several hours after meals Distress alone was present in the epigastrium and upper right quadrant in 12 instances Nausea was noted in nine, and vomiting in eight Eructations and distention occurred in eight cases Symptoms of acidity were noted in six instances, loss of appetite in six, and loss of weight in but three

A large number of cases are clinically





Fig 3 Note the distorted, elongated duodenal cap due to adhesions small filled ampulla at arrows



Fig 4 Note small shadow at arrow, presenting a filled ampulla.

series were located in the same site. In our series, the size of the diverticula ranged from 5 to 20 mm, the average being 8 millimeters. They are in direct relation with the head of the pancreas. Filling of the pancreatic and bile ducts is rarely observed, though, in one instance in our series, partial filling occurred. The caliber of the neighboring duodenum was slightly greater than normal in most instances, in several cases, marked dilatation was observed. The presence of a duodenitis, duodenal stasis, or lagging in the duodenum was a frequent roentgen finding. The emptying time of the stomach was normal in most instances. However, in cases of marked duodenal stasis or obstruction, the emptying time is retarded, depending largely upon the degree of obstruction.

The majority of these diverticula do not present inflammatory changes, but infection may occur, due to regurgitation of the duodenal contents, retention of food, or of foreign bodies. The regurgitation of duodenal contents into the biliary and pancreatic ducts not infrequently leads to infection of the gall bladder and pancreas.

Case (6) calls attention to the fact that, in certain instances, it is quite possible for a secondary dilatation of Vater's ampulla to occur with such extensive insufficiency that

infectious material from the duodenum may enter the ampulla and then into the pancreatic or bile ducts, ultimately producing inflammatory changes in the pancreas. In many of these cases he has found signs of co-existing pancreatitis with marked patency and dilatation of the ampulla of Vater, a condition also observed by Akerlund (7). Case demonstrated an x-ray plate of this type in a patient in whom the condition was confirmed by operation. Calculi are not infrequently observed in these diverticula. Since the early case reported by Chomel (8) in 1710, others have been reported. Cole and Roberts (9), in 1920, recorded this finding in a number of instances.

Occasionally the ampulla will fill following the administration of an opaque meal and it may then be visualized in the roentgenologic study. This occurs infrequently, according to Duval, Roux, and Beclere (10), and when present has been regarded, according to George and Leonard (11), as a probable indication of either a pathologic condition of the gall bladder or of the pancreas. The radiologic diagnosis of a filled ampulla is usually rather uncertain, especially so in differentiating between it and a true diverticulum or a crater of an ulcer. In fact, when filled, the ampulla presents the appearance of a true diverticulum of the du-

ticula have been observed with greater frequency. In all of these cases dyspeptic symptoms of some form occurred.

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## THE HEART IN PULMONARY TUBERCULOSIS

### A ROENTGENOLOGIC CONSIDERATION

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**A**LTHOUGH there exists an abundance of clinical medical literature on the association of heart pathology with pulmonary tuberculosis, the roentgen literature contains comparatively few references to it. Even the latest and most comprehensive text-books on x-ray diagnosis either omit the subject entirely or content themselves with scant remarks, culled almost exclusively from clinical data or autopsy reports.

A number of reasons explain this attitude. For a long time, the x-ray diagnosis of both pulmonary tuberculosis and heart pathology had to contend with numerous difficulties, many of which have been solved only very recently. The primary difficulties of a satisfactory and fairly standardized technic have been overcome by the introduction of more powerful radiographic machinery, which made the use of teleroentgenography possible and thus largely superseded the rather unpopular and dangerous method of orthodiagraphy. Then, the adoption of oblique and lateral positions in addition to the time-honored, but often less instructive, posterior-anterior view, as well as the more universal application of fluoroscopy, have enriched our radiologic armamentarium in such a degree that the accuracy of x-ray

diagnosis in many cases is equal, if not superior, to the clinical examination. Of course, this development has not yet solved all our diagnostic problems; every advance in science seems rather to multiply than to decrease them. But every advance is also a stimulus to more intensive work and an appeal to better co-operation of the different medical specialties. The enthusiasm which knew no limitations in the radiologic interpretation of "hilus enlargements" or "tuberculous activity" was undoubtedly unwarranted, but so were the diagnostic and therapeutic evaluations of "systolic murmurs" and "occasional râles" by the clinicians. While the limitations of radiologic diagnosis for the determination of tuberculous activity or the functional ability of the heart muscle must be admitted, roentgenology can, on the other hand, claim that, at the present state of development, it not only can give a definite diagnosis but also far surpasses other diagnostic methods in depicting the extent and damage of the disease. After all, it may not be quite amiss to emphasize again and again that all diagnostic (and therapeutic) methods are only links of a chain, not stronger than its weakest link and dependent for its strength on each individual link.

Any roentgenologic consideration of cases



Fig 6 Case of duodenal obstruction *A*, filled ampulla, *B* and *C*, small projections extending out from the ampulla, *D*, duodenal constriction



Fig 7 Note filled ampullar shadow at arrows, duodenum pulled up under the gall bladder area by adhesions

silent, others present symptoms that are by no means characteristic of this condition. The liver was observed to be enlarged in 23 instances, and tender on palpation in 20. The gastric contents revealed a normal acidity in 16, hyperacidity in 11, and hypoacidity and achylia in seven cases.

#### SUMMARY

Diverticula of the duodenum, although uncommon, have been observed with increasing frequency in recent years. They are of especial interest, due to their relation to the ampulla of Vater. The most common type is observed in the region of the ampulla, and is, at times, revealed in the roentgen-ray examination. This type, which is usually single, occurs on the inner and posterior aspect of the second portion of the duodenum.

Normally, the ampulla of Vater cannot be filled with barium in the x-ray investigation, but occasionally dilatation of the sphincter occurs, allowing a return flow of the opaque meal.

Although the filled ampulla of Vater may vary in size, it always occupies the same location. The mouth of the pouch is usually

large, hence, at times, it may reveal a retention of the opaque meal. The majority of diverticula do not present inflammatory changes, infections, however, may occur and regurgitation of duodenal contents into the biliary and pancreatic ducts may lead to infection of the gall bladder and pancreas.

In a large proportion of our cases, evidences of right upper quadrant and duodenal adhesions were present. Abnormal intraduodenal pressure and gall-bladder disease were also noted, therefore, it is quite possible that these affections may in some way be related as causative conditions. An anatomic weakness of the tissue involving the ampulla is probably an important primary etiologic factor.

The radiologic diagnosis of a filled ampulla is, at times, uncertain and there may be especial difficulty in differentiating this condition from a true diverticulum.

In a study of 34 cases the filling of the ampulla of Vater was observed during the usual roentgen examination of the gastrointestinal tract. The fact that but 34 cases were noted in many thousand x-ray examinations is an indication of the rarity of this condition, however, in recent years diver-

patients belonged to the age period over 45 years. Many of them were actively employed (often in strenuous work) and, consequently, more subject to cardiovascular strain than the average sanatorium patient. Then, over two-thirds of this number are taken up by cases of microcardia and cardiac displacement, an observation so frequent in pulmonary tuberculosis that it is often disregarded entirely. Further deduction of 13 cases of pathology of the aorta reduces the number of definite organic heart lesions, expressed roentgenologically by enlargement, changes in configuration, etc., and confirmed clinically, to 65 (8.6 per cent of the total), or, if only valvular lesions are counted, to only 27 (3.6 per cent of the total). Since only cases with definite roentgen signs were included and uncomplicated prominence of the pulmonic conus in microcardia was also omitted as of no pathologic significance, this percentage is too low rather than too high. Incidentally, it may be mentioned that, outside of these cardiovascular complications, a total of 399 other complications were diagnosed either roentgenologically or clinically in our series of 750 patients. The latter complications will be discussed in a separate article.

The frequent observation of the small heart in tuberculosis has given rise to numerous discussions and widely divergent interpretations. Roentgenologically, it is defined as the heart in which the angle of inclination is greater than 55 degrees. The condition has been described (and disputed) under an impressive galaxy of names: microcardia, small heart, asthenic heart, atrophic heart, hypoplastic heart, cor pendulum, drop heart (Tropfenherz), and many others. While one author (Norris) found it only three times in 1764 autopsies of tuberculous patients, another (Guarini) found it in no less than 68 per cent of 1,400 tuberculous patients. We observed it in 146 patients out of 750 approximately 19.5 per

cent. While the majority of phthisiologists accept it as a definite pathologic entity (dystrophy or hypoplasia) characteristic for tuberculosis and other wasting diseases, others consider it as a kind of *fata morgana* due to axial rotation of the heart or to abnormally low position of the diaphragm. A similar divergence of opinion exists in regard to its significance. Geigel considers it a direct etiologic factor in the development of pulmonary tuberculosis. Latham and others describe it as a sign of poor prognosis. Kerley believes that the apparent relation between a small heart and pulmonary tuberculosis is due to the fact that the small heart is always found in a long and narrow chest and that the incidence of pulmonary tuberculosis is high in individuals with narrow chests. While our observations confirm the latter statement, the former appears subject to so many exceptions as to be untenable. Excluding cases of emphysema, we found a certain number of small hearts in patients of decidedly hypersthenic habitus. Undoubtedly, in some cases microcardia is only apparent and a result of rotation or other mechanical changes, but such cases can be excluded by a suitable radiographic and fluoroscopic technic. As recently shown by Benvenuti, microcardia represents in most cases a real hypoplasia or dystrophia and may assume a decided prognostic significance, manifesting poor body resistance and general asthenia. In many of these cases the fluoroscopic examination reveals a feeble heart beat and poor heart action. Our observations, however, do not coincide with Benvenuti's conclusions that microcardia is a typical sign of the first and second stages of tuberculosis and is usually replaced by hypertrophy in advanced cases. In this connection, the view of Woods Hutchinson deserves mentioning. He holds that all species of animals with a heart relatively small in proportion to the body weight are very susceptible to tuberculosis, while others with

TABLE I

Cardiovascular phenomena	Age incidence			Tuberculous classification			
	Under 25 years	25-45 years	Over 45	Minimal	Moderately advanced	Far advanced	Miliary
Small heart.....	31	71	44	38	46	62	---
Cardiac displacement.....	20	49	24	10	28	55	---
Right ventricular enlargement.....	5	9	13	---	8	19	---
Congenital heart disease.....	2	---	---	1	1	---	---
Mitral disease.....	1	3	1	3	2	---	---
Aortic disease.....	---	4	9	6	4	3	---
Mitral-aortic combined.....	---	2	5	4	2	1	---
Non-valvular or unclassified enlargement.....	---	3	8	7	3	---	---
Enlargement of aorta.....	---	2	9	6	5	---	---
Aneurysm of aorta.....	---	---	2	2	---	---	---
	59	143	115	77	99	140	---

of pulmonary tuberculosis is handicapped by the fact that none of the many attempts at classification have done full justice to the importance of the roentgenogram. From the standpoint of the radiologist, the classification of the National Tuberculosis Association has little or no advantage over the old-fashioned Turban-Gerhardt classification or the pathologic-anatomic classifications of Kupferle, Aschoff, and others. Nevertheless, the classification of the National Tuberculosis Association is used in this paper for uniformity and for purposes of comparison. It is hoped that the planned revision of this classification will take the requirements of the roentgenologist more into consideration.

The material studied by us comprises 750 consecutive cases of pulmonary tuberculosis referred to the X-ray Department of the University of Colorado School of Medicine and Hospitals during the last five years.

In the majority of chest cases, our routine radiologic technic included stereoscopic views supplemented by fluoroscopy and, especially in the case of suspected heart pathology, lateral and oblique views. Whenever possible, teleroentgenography was employed. For the measurement of the cardiac diameters the standard tables of Clayton and

Merrill, Hodges and Eyster, Dietlen, and others were used.

Of the 750 patients studied, 379 were men, 371 women.

	Patients	Per cent
Under 25 years of age	176	23.5
From 25 to 45 years	358	47.7
Over 45 years	216	28.8

The following figures are given for the classification of tuberculous stages:

	Cases	Per cent
Minimal tuberculosis	179	23.9
Moderately advanced tuberculosis	211	28.1
Far advanced tuberculosis	353	47.0
Miliary tuberculosis	7	1.0

In 317 cases (42.3 per cent) the X-ray report mentioned an abnormal or pathologic appearance of either the heart or aorta.

At the first glance, this number of cardiovascular complications appears unusually high. It will, however, be readily understood if several factors are considered. First, the patients—either admitted through a general out-patient department or through the wards of a general hospital and a psychopathic hospital—differ widely from those usually seen in a tuberculosis sanatorium or clinic both in age and physical constitution. Almost one-third of the observed

Enlargement of the right ventricle (due either to hypertrophy or dilatation or both) is of common occurrence in chronic pulmonary tuberculosis and is amply confirmed by analogous autopsy findings. In a series of 120 cases of tuberculosis, Hirsh found right ventricular hypertrophy in 35 per cent. Less conclusive are electrocardiographic findings, except in cases of pneumothorax (Bronfin and collaborators). This enlargement, as a rule slight and similar in its roentgen appearance to mitral stenosis, is due to the abnormal resistance in the pulmonary circulation caused by the tuberculous lung changes. Occasionally, the condition is referred to as "cor pulmonale." A differentiation between simple hypertrophy and dilatation (which naturally ensues after failure of the heart muscle) is roentgenologically impossible in most cases.

A case of congenital heart disease was diagnosed in a boy of 13 who exhibited the typical signs of pulmonary stenosis. Clinically, cyanosis, clubbing of the fingers, etc., were signs, radiologically, dilatation of the right ventricle and enlargement of the pulmonary conus, but no widening of the left auricle. The other case involved a girl of 17 years with similar, though less marked, symptoms. There was the additional suspicion of a patent foramen ovale. Final judgment as to diagnosis and progress of the disease must be withheld in both cases, since further data could not be obtained after the patients left the hospital. In one case the tuberculous involvement was minimal, in the other, moderately advanced. There is little doubt that, in the cases of right ventricular enlargement, the pulmonary tuberculosis preceded the heart pathology, in cases of congenital heart disease, the opposite relationship must be assumed. In the majority of the remaining heart lesions it is, however, impossible to ascertain the relation as to time and priority of the two pathologies with any degree of certainty.

While theoretically all ostia of the heart are subject to valvular lesions, the mitral and aortic valves are the most important.

Mitral disease produces a rather typical roentgenographic appearance. In early cases we observe dilatation of the left auricle, soon to be followed by bulging of the pulmonary conus and obliteration of Holzknecht's space. Later, hypertrophy and dilatation of the right ventricle ensue. In pure mitral stenosis, the left ventricle does not enlarge, but such a condition is rare. In most cases we have to deal with a combination of mitral stenosis and mitral insufficiency. The heart assumes the "mitral configuration," or "standing egg," or "sugar loaf" shape. Frequently displacement of the esophagus can be demonstrated by barium administration. Our reports showed mitral disease in five cases, which is a small percentage when the preponderance of the lesion is considered. None of these cases belonged to the far-advanced group of tuberculosis.

Just as a differentiation between mitral stenosis and insufficiency is frequently impractical or unfeasible, aortic stenosis (uncomplicated, a rare disease) and aortic insufficiency are usually combined under the heading of "aortic disease." The X-ray findings are characteristic: enlargement of the left ventricle produces the typical "boot shape," or "lying egg shape," of the heart, often together with prominence or enlargement of the aortic arch. The high incidence of this disease among our patients is explained by the frequent occurrence of syphilis, rheumatism, hard work, old age, and other etiologic factors. A direct interrelation between aortic disease and pulmonary tuberculosis appears improbable.

The following table, modified after Markovits, recapitulates the main differential points in the radiologic diagnosis of the uncomplicated "mitral heart" and its counterpart, the "aortic heart."

proportionately larger hearts are almost immune to infection

The next frequent observation in pulmonary tuberculosis is cardiac displacement. The consensus of opinion accepts traction by fibrosis and pleuropericardial adhesions as the main cause of the displacement. In a smaller percentage of cases it is due to pressure from pneumothorax, pleural effusion, and similar causes. Its eminent importance for the indication and prognosis of collapse therapy is generally appreciated. Its significance in other cases was recently stressed by Clayson. He considers afebrile tachycardia, which frequently results from cardiac displacement, of sufficient purport to recommend treatment as soon as the diagnosis is established by x-rays *etc.*, before the onset of clinical symptoms. For this and for prophylaxis, breathing exercises are prescribed whenever they are rendered safe by the condition of the lung. The development of clinical symptoms Clayson considers an indication for phrenic evulsion. We observed most cardiac displacements in far advanced tuberculosis. In the majority of cases the displacement was toward the affected side. In only 10 cases out of 93 was the displacement toward the unaffected or less affected side. This occurred in pleural effusions, pneumothorax, and thoracoplasty. Right-sided displacement never assumed the proportion of dextrocardia reported by some observers.

A comparison between roentgen reports and clinical findings proved the superiority of x-rays for the diagnosis both of microcardia and cardiac displacement. In many instances auscultation and percussion failed to reveal the condition even in pronounced phases of development.

Of the greatest theoretic and practical interest is the association of pulmonary tuberculosis with organic heart disease. Ever since Rokitsky, more than 80 years ago taught the antagonism between pulmonary

tuberculosis and heart disease, the problem has attracted wide attention, though it has never been settled definitely. It is true the "absolute antagonism" as set forth by Rokitsky has long been refuted by an immense amount of statistical material. Practically all observers, however, agree that a certain interrelation between heart pathology and pulmonary tuberculosis cannot be denied. Chronic pulmonary congestion, as, for instance, is observed in mitral stenosis, is credited with exerting a distinctly inhibitory influence on the development of pulmonary tuberculosis. Tiegel's experiments in rabbits and dogs, producing stasis in the pulmonary circulation and consequent pulmonary hyperemia by partial ligation of the pulmonary veins, showed a marked retardation of infection in the hyperemic lung after intravenous injection of virulent cultures of tubercle bacilli. Conversely, valvular lesions producing pulmonary anemia seem to predispose to tuberculosis. This theory is apparently confirmed by the fact that pulmonary stenosis, which markedly interferes with the pulmonary circulation, is complicated in 50 per cent or more of the cases by pulmonary tuberculosis (Kellner, Lebert, and others). Statistics relative to the incidence of cardiac lesions in tuberculous patients vary considerably. By clinical examination Meisenburg found 53 cases (1.14 per cent) of cardiovascular disease in 4,649 tuberculous patients, Turban in Davos 8 (2 per cent) in 408 cases. The percentage is higher in autopsies. The highest incidence (16 per cent) is reported by Hugh Walsham. Recently, Strazhesko reported 74 (3.1 per cent) in 1,961 cases of tuberculosis, compared with tuberculosis in 13.6 per cent of cases in 522 heart cases. The fact that pulmonary tuberculosis shows a predilection for earlier ages, while heart disease is more frequently encountered in later periods of life, makes in itself all statistical conclusions more difficult and problematic.

cent the changes represented valvular lesions. Most patients with organic heart changes, right ventricular enlargement excepted, showed minimal or moderately advanced tuberculous involvement. The prognostic and therapeutic importance of cardiovascular complications in pulmonary tuberculosis needs no further emphasis. The complex problem of interrelation between heart pathology and tuberculous infection of the lungs still lacks a satisfactory solution.

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PNEUMONOCOONIOSIS<sup>1</sup>

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**P**ULMONARY pathology caused by the inhalation of various dusts is pre-eminently a field for study by radiologists. Although many investigations have been made and numerous articles written by health and industrial physicians and investigators, American radiologists, with few exceptions, have apparently ignored the subject. The purpose of this paper is to stimulate a general interest and further research, from a radiographic standpoint.

Dust inhalation in sufficient quantity to cause pulmonary changes is, as far as we know, strictly an industrial hazard, and as the radiograph is the easiest, the surest, and often the only means of diagnosis, our responsibility is the more evident. I know of no radiologist so isolated from industry that its hazards do not present a problem in his practice. All pulmonary pathology pro-

duced by the various dusts is grouped under the general term pneumoconiosis, while such terms as "silicosis," "anthracosis," "siderosis," and so forth, are used to indicate pulmonary damage when the greatest number of particles inhaled is derived from a specific material. It is of historic interest to know that the clinical aspect of pneumoconiosis among metal miners was described by Hippocrates and by Agricola. It was differentiated from true pulmonary tuberculosis in 1862 by Dr. Peacock after examination of several hundred miners. Great Britain has contributed much to our knowledge of the subject by complete investigation and the writings of Haldane and Collis are outstanding. The investigations and reports of the Miners Phthisis Prevention Committee and Miners Phthisis Medical Bureau of the Union of South Africa are classics in this field of research. In the United States the U. S. Public Health Serv-

<sup>1</sup>Presented before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.



TABLE II

	Mitral heart	Aortic heart
Aortic arch	Normal or smaller	Prominent
Pulmonic conus	Enlarged (curves often confluent)	Normal
Left auricle	Enlarged (curves often confluent)	Normal
Left ventricle	Normal or smaller	Enlarged
Right upper curve	Normal	Normal or slightly convex
Right auricular curve	Enlarged, subdivided	Normal
Heart shape	"Standing egg" "sugar loaf"	"Lying egg," "boot shape," "duck shape"
Heart contours	"Staircase" effect	Pronounced
Extension	Vertical	Horizontal
Heart apex	Normal slender, or angular, subphrenic	Blunt, broad, circular, above phrenic arc
Increased pulsation	Over pulmonic conus	Over aorta and left ventricle
Similar configurations in	Juvenile heart, asthenia, blood diseases, congenital heart disease, etc.	Senile heart, "renal heart" "gutter heart" (Kraus), myocarditis, kyphoscoliosis

The combination of mitral and aortic disease was encountered in seven cases. Roentgenologically we see, in addition to the enlargement of the left auricle and right ventricle as a result of the mitral disease, an enlargement of the left ventricle and aorta, due to aortic disease. The transverse diameter of the heart is considerably enlarged. From the crossing of the aortic "lying egg" and the mitral "standing egg" (or, if we prefer, from the mating of the "boot" and the "sugar loaf") results a configuration which, by the way of some strange terminologic evolution, was termed "pear-shape" by Kerley. (That the same term is used by the Heart Committee of the New York Tuberculosis and Health Association to describe the hypoplastic or drop-heart induces further confusion into an already more culinary than scientific nomenclature.)

No cases of lesions of the tricuspid valve were observed.

In 11 cases, more or less general enlargement of the heart was reported without any definite evidence of valvular lesions. Some of these were ascribed to arteriosclerosis, chronic myocardial disease, and hypertension, in others, etiology and classification remained undetermined. One patient suffered from chronic nephritis. Most patients belonged to the age group over 45 years, in most, the tuberculous infection was little pronounced.

The seven cases of miliary tuberculosis did not show any heart pathology.

Of the nine patients with aortitis and aortic enlargement, seven were men, two women, and all were over 40 years of age. In two cases, sclerotic changes (calcified plaques) were reported. None of these showed advanced tuberculosis.

The two cases of aortic aneurysm—men over 45 years of age—showed minimal tuberculous involvement. The small number does not allow any conclusions, although it is worth mentioning that, according to Rokitsky, aortic aneurysm is an important antagonist of pulmonary tuberculosis.

In the majority of cases with aortic pathology either the blood or the spinal fluid showed positive Wassermann reactions.

No cases of pericarditis or of tuberculosis of the heart proper were observed. It is improbable that, apart from pericardial effusion and adhesive pericarditis, X-rays can be of help in the diagnosis of such cases.

#### RFSUML

In a high percentage of patients suffering from pulmonary tuberculosis, cardiovascular pathology was found roentgenologically. The majority of these findings refer to microcardia and cardiac displacement. In 86 per cent of 750 tuberculous patients organic heart changes were diagnosed, in 36 per

Entrance of particles into the alveoli causes a proliferation of phagocytic cells, generally believed to be derived from the endothelium of the lymphatics and capillaries. These cells take up the particles and enter the lymph spaces around the alveoli sacs and in the interlobular spaces. Some of the dust-laden cells re-enter the air passages and are coughed up. This is the only manner in which particles, after once entering the tissues, are excreted. After these dust-laden cells enter the lymph spaces they move with the lymph stream toward the hilum nodes. Many of the cells are arrested in the deposits of lymphoid tissue or in clumps in the spaces along the innumerable branches of the arterial and bronchial trees, and many of them reach the hilum and tracheobronchial nodes. Wherever a group of dust cells collect, there is set up an irritation and the process of fibrous tissue formation begins. The lymphoid deposits are first to receive the dust cells and are the first areas to become fibrosed, this is followed by blocking of the lymphatic drainage and further collection of cells in the spaces which, in turn, become obliterated by fibrosis. With destruction of the lymphatics in one area, their functions are assumed by others and the process is repeated. The fibrous tissue is produced by stimulation of fibroblastic proliferation of existing connective tissue structures and by transition of dust cells into fibroblasts. After a certain point is reached the process becomes manifested on the radiographic film as the increased bilateral linear markings of peribronchial and perivascular fibrosis of first stage pneumoconiosis or the small discrete round densities of second stage. With continued dust inhalation in large amounts the fibrotic process continues to progress, the discrete nodules become more numerous, increase in size, and coalesce with adjacent areas, the fibrous framework of the alveoli, blood vessels, and bronchi is markedly thickened, the hilum

and tracheobronchial glands show further enlargement characteristic of the third stage, which, if advanced, shows massive consolidation. At autopsy the lung is found to be firm, inelastic to the touch, cuts like gristle, and imparts a gritty sensation to the knife. The pleura is thickened and many adhesions to adjacent structures occur. It has been determined that the weight of silica dust obtained from the lung of a miner varied from 28 grams to 96 grams, while from a normal lung only 0.5 gram is obtained.

Pneumoconiosis, according to the progress of the disease, is usually described in three stages, namely, first, second, and third. The clinical, pathologic, and radiographic findings coincide to a remarkable degree. The increased radiographic densities are due to increased fibrosis and not to shadows cast by dust deposits.

In the first stage the radiograph shows an increase of the lung root shadows beyond normal limits due to enlargement of the lymph nodes and thickening of the larger bronchi and vessels. The branchings of the bronchial and vascular trees appear more numerous and are wider and denser than normal. As the pleura is approached the size and density of the shadows tend to decrease. The spaces between the more prominent markings, which in the normal lung are usually clear, show many fine linear shadows. The markings of this stage are all linear in character, no mottling is seen and adhesions are rare. The condition is bilateral, with a fairly even distribution in all lobes, however, the right lung or the lower lobes may show the greater advancement due to the greater amount of air going to these locations. Passive congestion and chronic infection may produce somewhat similar changes, but the markings are not usually so clear-cut nor so definitely symmetrical as are those of dust pathology.

In the second stage, the hilum shadows

ice and the U S Bureau of Mines have made extensive studies and reports, and from a radiographic standpoint, the book "Pneumocomiosis" by H K Pancoast and E P Pendergrass is the most complete and comprehensive work published to date

To better appreciate our radiographic findings, it is well to review the etiology and pathology of pneumoconiosis

The active agents in the production of this condition are the minute particles of inhaled dusts which reach the alveoli of the lungs. In all probability many dusts, not yet studied, may produce pulmonary changes if inhaled in high concentrations over a sufficient period of time, but so far silica dust,  $\text{SiO}_2$ , has been found to be the most dangerous and produces the most extensive changes. It is only the finest dust particles that remain afloat in air and are inhaled. Dust particles which reach the alveoli are usually less than 10 microns ( $1/2500$  inch) in diameter and 70 per cent are not more than one micron ( $1/25000$  inch) in diameter. The particles larger than 10 microns in diameter are removed by the secretions of the nose and the larger bronchi and are expelled by the upward action of the cilia and by the act of coughing. To determine whether or not the quantity of dust in the air in any given location is sufficient to be dangerous it is necessary that a sample of air be taken by special dust-collecting apparatus, and the weight, number and size of the particles be ascertained. The Miners Phthisis Prevention Committee in its final report recommends the following standard of purity for air, as determined with the Kotze Konimeter: less than 100 particles per cubic centimeter very good, between 100 and 200, good, between 200 and 300 fair, above 300, unsatisfactory. One hundred particles per cubic centimeter is the same as 100,000,000 per cubic meter. This standard was suggested for mining operations in instances in which the silica content

of dust was very high. In its General Report the Committee states that street air on a windy day averages 15 milligrams by weight and 20,000,000 particles of fine dust (not more than 5 microns in diameter) per cubic meter. It is readily to be seen that very dusty street air is rated very good from a health standpoint as it contains less than 100 particles per cubic centimeter. In many industrial operations the amount of dust exceeds this standard.

Pneumoconiosis has been found in workers in many occupations. It is produced in the shortest period of time and most frequently with most extensive pathology in hard rock miners, hard coal miners, granite cutters, metal grinders, and potters. In some instances the condition has developed in one year's time. It has also been found among sand blasters, soft coal miners, brick makers, cement workers, firemen, stokers, asbestos workers, charcoal burners, hardwood and some textile workers, but a much longer time, usually from 5 to 40 years, was required to produce the pathology.

The exact manner in which the dust particles cause injuries is not known but the most generally accepted theory has to do with the solubility of particles and their toxic action on the tissue cells. Another theory suggested is that when the cells take up enough particles their life processes are slowed and they are hindered in performing their physiological functions. The theory of mechanical injury due to the sharp cutting edges of particles has been abandoned by most investigators.

The production of dust pathology starts when there is in the air a greater number of fine particles than can be removed by the nose and upper respiratory apparatus and when a larger quantity reaches the alveoli than can be taken care of by phagocytosis, in other words, when the intake of particles is greater than the excretion.

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#### DISCUSSION

DR. R. T. PHILL (Ottawa, Ill.)—In Otta-  
wa, Illinois, we have probably the largest silica  
mine in the world. While we produce the silica,  
the problem of pneumoconiosis is by no  
means confined to our particular locality. It  
is widely distributed in practically all industry.  
In South Africa, in the mining districts, pneu-  
moconiosis was so bad that I have been  
told that have almost closed mining indus-  
try. Such a thing could not occur in this  
country. If improper legislation should be  
passed in the way it has been passed in British  
South Africa, the burden on the employers  
would become so tremendous that it would

amount to confiscation. I tried to interest the  
producers of this sand some fifteen years ago  
in making a study of the situation, but be-  
cause of the fact that they did not want to  
arouse any incitement on the part of their em-  
ployees, nothing was done. Now that the sub-  
ject has come to the closer attention of the em-  
ployers and certain lawyers who are now too  
scrupulous, these companies have had several  
suits brought against them. Two years ago I  
made an examination of some two hundred  
and fifty employees. Since then suits have re-  
cently been filed, the companies have now de-  
cided to have a physical examination made  
once every three months and a physical and  
x-ray examination every six months.

This condition occurs in your practice the  
same as in mine. It is widespread. It is found  
in the metal industry, the pottery industry, the  
manufacture of glass, the automobile industry.  
For instance, in the automobile industry they  
use what they call a "universal grinding tool,"  
a dangerous source of pneumoconiosis. Where-  
ver you are located, the situation will  
present itself to you and if you can interest  
manufacturers from the standpoint of their  
own self interest in having x-ray examina-  
tions made of their employees, in spite of the  
fact that they may feel that they had "better  
let sleeping dogs lie." I think it would be to  
their interest. For instance, I have been called  
in consultation just recently by a large manu-  
facturer because his company has a case on its  
hands now that is going to amount to about  
\$20,000. It is the first case in that State and  
probably will be a test case. The man clearly  
has a tuberculosis, no signs of pneumoconio-  
sis whatsoever, but he stands a good chance  
to win the suit. If the medical department of  
this plant had had x-ray films made of the  
employees in every dusty department, I think  
they would have been protected.

I would like to have Dr. Phill explain the  
dust counting apparatus a little more in de-  
tail. It would be of great value to manufac-  
turers to have tests of the dust content of their  
various departments made.

DR. J. A. GATHERDALE (Phoenix, Ariz.)—  
We see pneumoconiosis quite frequently in  
our field, especially complicated with tuber-

and linear markings of the broncheovascular trees usually show further increase in size and density, but, in addition, there are seen many small, round, discrete densities which produce the effect of generalized mottling on the film. The mottled appearance is due to fibrosis of the many lymphoid tissue deposits of the lymphatic system. The discrete shadows vary in size from about one millimeter to ten millimeters in diameter the larger being partly due to coalescence of smaller nodules. The nodules show a fairly even distribution throughout both right and left lobes but are usually more numerous in the right. The pleura is thickened in some areas, and the diaphragm, particularly the inner portions, may be irregular and roughened from adhesions.

In the third stage the extensive generalized interstitial fibrosis displaces the more or less discrete and sharply defined markings of the first and second stages. The small discrete nodules of the second stage coalesce to form larger irregular masses which, on the radiograph, produce the "snow-storm effect," characteristic of this stage. If the fibrosis continues with further confluence of the larger densities, massive consolidation is produced. The consolidations are usually bilateral, and in extent may involve any part of a lobe or an entire lobe, most often the upper. This stage shows more extensive pleural thickening and adhesions, particularly to the diaphragm, often causing marked elevation and irregularity. The heart and large vessels are pulled toward the right side and often occupy a vertical position in the thorax.

The existence of pneumoconiosis establishes a predisposition to intercurrent respiratory infections, and tuberculous infection may become engrafted on dust pathology during any stage but most usually in the second or third stages.

As its presence is frequently a difficult matter to determine from the radiographic

film alone, a few differential points will be noted here. Pneumoconiosis is bilateral, symmetrical, affects all lobes, the shadows are clear-cut, well defined and hard in appearance, the apices are usually clear until far advanced, and no cavitation occurs. Tuberculosis is ordinarily unilateral, not symmetrical, the apices become involved early, it is generally confined to the upper lobes, the shadows are not so clear-cut or well defined and are softer in appearance, and cavitation occurs with advancement.

#### CONCLUSIONS

In conclusion, I wish to emphasize the following facts:

1 Inhalation of dusts is essentially an industrial hazard, many and varied occupations presenting it.

2 So far, silica dust has been found to be most harmful, but other dusts produce lung changes to a lesser extent if conditions are suitable.

3 Only very fine dust particles, less than 10 microns in diameter, reach the alveoli and cause pathology.

4 The changes produced are fibrosis of the lymphoid deposits and lymphatic drainage system.

5 The radiograph presents a definite picture of the progress of the disease. It is the easiest, surest, and often the only method of diagnosis, and we should more generally, interest ourselves in further study of this condition.

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early second stage from miliary tuberculosis. In most of my examinations we do not depend upon the radiographs alone, but we take into consideration the history and physical findings.

In miliary tuberculosis there are temperature and clinical findings which are indicative of the condition. Most likely the history of past occupations would exclude dust, whereas in a pneumoconiosis the history of occupation is of primary importance. Question the patient thoroughly as to the type of work he does, if that work produces dust, if his face is close to the operation, and if he inhales the dust.

There is one point to remember—the operator inhales a dust that is not visible—the dust that is visible in the air is harmless because it is too coarse to penetrate the alveoli of the lungs, it is caught in the upper respiratory passages and excreted. Even in a beam of light you cannot see the dust less than 10 microns in diameter.

I would like to see some one make lipiodol injections to study the question of bronchiectasis with pure pneumoconiosis, not complicated with tuberculosis. I have not seen any study made along that line yet, but I would like to have some reports on it in the future.

## PRESENT RESPONSIBILITIES IN DENTAL RADIOGRAPHY<sup>1</sup>

By CLARENCE O. SIMPSON, M.D., D.D.S., F.A.C.D., Professor of Radiodontia,  
Washington University School of Dentistry, St. Louis, Missouri

**C**ONTINUOUS readjustment and progress are imperative in the practice of radiology, and individual ability is taxed to keep pace with the developments. The practice of dental radiography and interpretation, the concise term for which is "radiodontia," has advanced in common with other phases of radiology. Prior to the last decade, extensive alveolar lesions were so prevalent that they could be discovered by superficial x-ray examinations and defective vision, but most of these have been eliminated. The pulpless tooth frenzy was a boon to inefficient radiodontic service in that it was necessary only to reveal and condemn teeth with canal fillings, but most of the pulpless teeth have been eradicated, without due discrimination. Now the requirements of dental radiography have materially changed, but without a corresponding improvement in the general standard of service to supply the need.

In the zeal for condemning pulpless teeth, the dental and medical professions generally ignored diseased vital teeth and periodontal

sepsis, which are more virulent than average pulpless teeth. There is an obvious reaction in medical practice, even among the supposedly precise internists, in neglecting investigation of dental conditions, excepting in disorders popularly associated with focal infection. Vital resistance, metabolism, and toxemia must be considered in functional disturbance and organic disease.

The unhygienic dental conditions in the majority of adults contribute to most ailments. Dentists with radiographic equipment cannot usually be depended upon to exclude oral sepsis, because their examinations are inadequate and the conclusions are ultraconservative. A thorough, unprejudiced investigation, such as is required to decide the issue, should be a routine diagnostic procedure.

The extreme conservation of dental pulps has led to the repair of carious teeth in which the pulps were diseased and the application of extensive metallic restorations to vital teeth, with a resulting harvest of septic degeneration. Many degenerating pulps do not produce local symptoms, yet they respond to vitality tests for months and

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

culosis or bronchiectasis. In the Southwest, the hard rock and the copper mines present the same problem. I would like to ask about the form which resembles miliary tuberculosis. We see this form quite frequently in the copper districts. The patients are frequently sent with the diagnosis of miliary tuberculosis. One is very apt to make this mistake if he is not careful. The distribution in this type of lesion is similar to that of miliary tuberculosis, but lesions are clearer cut on the x-ray film.

The big problem lies in the attendant dangers of bronchiectasis, tuberculosis, or cardiac insufficiency. Physical examination is usually negative except for the emphysema present, which hides the underlying pathology. X-ray films show only the marked fibrosis present. When tuberculosis is present with pneumoconiosis, it is impossible at times to determine which is which. One must consider the use of artificial pneumothorax in these cases. It presents quite a difficult problem, due to the decreased vital capacity. I have used this procedure only twice for closure of cavities and feel quite hesitant in doing it.

I happened to see one case in which pneumoconiosis developed in about six weeks' time. This was in 1927, in the clinic of Dr. Dunham, of Cincinnati.

In Arizona we are trying to control the dust problem by the use of water in the mines. Jarvis did considerable work in this field among the granite cutters in Vermont. He showed also that in many cases some clearing of the pneumoconiosis occurred when the men were taken out of the dusty occupation.

DR. FLINN (closing). As Dr. Pettit brought out in his discussion, this condition is much more widely distributed than in the past we thought it to be. If we familiarize ourselves thoroughly with it, we can find it in many occupations in which we never suspected it before, produced by dusts which we thought were harmless.

Then there is a second consideration. That is, one industry takes on an employee and, if he is not examined roentgenographically at the time of his employment, he brings a hazard

into the industry to himself for which the industry is not responsible.

Often it is difficult, in the first stages, to differentiate it from early tuberculosis. The fact that pneumoconiosis is evenly distributed, from the hilum shadows to the periphery, with the apices and upper portions of the lungs relatively clear, gives a clue to the proper diagnosis.

There is a duty imposed upon us to make a diagnosis of pneumoconiosis rather than tuberculosis, if the man is to be laid off from work and put through a long period of rest for curative purposes. If he has pneumoconiosis, it is necessary only that either he change his occupation to one more free from dust, or that the dust be removed from the air at the place of his occupation.

The instrument for examining this dust is quite a technical affair. The test has to be carried through with technical precision, to be of any value. To almost any industry suspected of a dust hazard, the United States Bureau of Mines, or the United States Public Health Service or the United States Department of Agriculture will bring this instrument, usually making a survey of the air at the site of the operation and other comparative examinations around the same plant or locality.

I happened to be with the United States Bureau of Mines when the instrument was introduced, and I was present at the field test. Using distilled water in the bottle which collected the dust, we picked the sample and sent it back to the laboratory in Pittsburgh. A month later there was no dust in the sample although at the time of collection the solution was cloudy. So we discovered that distilled water dissolves silica dust. Then we had to experiment to find the solution which would carry the dust until the time of examination, finally discovering that grain alcohol was the best.

If any of you wish dust examinations made of the air in any industry in your community, a request to one of those three departments will probably produce results. In fact these people are usually glad to make surveys. All reports are strictly confidential.

It is hard, many times to differentiate an

liable to be misinterpreted. The decision regarding the immediate or deferred repair of carious teeth may be based on the assumption that decalcification has progressed farther than the apparent radiolucency and bacterial toxins have penetrated beyond the decalcification.

Thorough radiodontic examinations entail a sufficient number of views to reveal the essential, different aspects of the teeth and alveolar process. Sixteen views are the minimum requirement, more are necessary when there are special problems. This provides for three views of the maxillary incisor region to shift the images of the superimposed structures and compensate for the curve of the dental arch. The radiographs must present approximate anatomic perspective, sharp definition, and suitable density and contrast.

Accurate interpretation is based upon extensive study of the normal range of anatomic variations which are to be distinguished from pathologic changes. The variations are in bone types, anatomic landmarks, tooth forms, and localized peculiarities. In addition to recognizing structural diversity, the changes resulting from abnormal function must be excluded from evidence of disease. Deficient function and trauma produce reactions which are liable to be misinterpreted. There is a tendency for teeth without occlusal opponents to extrude and for the bone to increase in radiolucency from disuse atrophy. Similar, but less marked, appearances may be observed around teeth which are not vigorously used. Occlusal trauma, in excess of the compensatory resistance of the alveolar process, causes a periapical bone destruction which is difficult to distinguish from that resulting from infection.

Radiodontic interpretation should be concentrated upon evidence of incipient disease which offers a favorable prospect for conservative treatment. The discovery of

hopelessly diseased teeth is not cheerful news for the patient, nor is the diagnosis of an ailment at autopsy of value to him, yet this type of dental diagnosis has been too common. Early pathologic changes are usually in the periodontal membrane, the lamina dura, and the interdental septa, which should be clearly disclosed and critically studied in radiographs. Abnormalities in these structures are more significant than localized radiolucencies, which may be due to anatomic features. Only by routine examinations, systematic technical procedures, and refined interpretation can radiodontic service discharge the moral and legal obligations assumed in practising this phase of radiology.

#### DISCUSSION

DR. DALTON RICHARDSON (Austin, Texas)  
We who have had the benefit of Dr. Simpson's personal instruction in technic and interpretation know the accuracy with which he analyzes the technical and pathologic findings in dental films. He is conservative in his interpretations because he has seen the shortcomings of the radical physician, surgeon, and dentist who attribute all the ills of humanity to a dead tooth and the radiolucent area at its apex.

His thoroughness in presenting his subject leaves very little for me to discuss except to emphasize what he considers one of his most important findings—the evaluation of the vital tooth.

The prevention of a tooth from becoming non-vital, or, as frequently named, "dead" depends upon the recognition and approved treatment of the small, almost incipient caries and the changes in the periodontal and alveolar structures which, to the experienced roentgenologist, are indicative of early disease. It is the early recognition of this diseased condition, when the bacterial products are being carried through the systemic circulation, that enables the roentgenologist to co-operate with the internist, the surgeon, and the dentist so that the effects of focal infection may be eliminated. It is at this time that the best possible



perhaps years after becoming septic foci with circulatory connection. Radiography is the only method by which most of them can be discovered, and careful examinations with accurate interpretation are required to diagnose the subtle periapical changes.

The disregard of periodontal infection, even in advanced stages of pyorrhea alveolaris, has been excused by the explanation that there was drainage from the gingival pockets. However, the drainage is not constant or thorough, and chronic suppuration cannot be ignored as evidence of local disease and a systemic menace. Read has isolated 16 strains of bacteria, including *Streptococcus pyogenes* and *viridans*, from pyorrhea pockets. Since the blood and lymph circulation in gum tissue is conducive to metastatic infection, the obsolete theory that the drainage of pus from pyorrhea pockets eliminated the risk of focal infection should be corrected to the rational theory of persistent suppuration which has overwhelmed cellular resistance and demands corrective treatment.

Efficient radiodontic examinations offer the most accurate means of differential diagnosis in periodontal disease. The early alveolar changes, indicative of incipient periodontoclasia, can be distinguished in excellent radiographs years before the clinical evidence will be observed by dentists. Early diagnosis and elimination of the etiologic factors are the most effective measures in controlling the increasing ravages of pyorrhea alveolaris. Infiltrating periodontoclasia, which permeates and disintegrates the bone far in advance of the pocket formation, necessitating prompt removal of the teeth to conserve the alveolar process for the stability of artificial dentures can be distinguished only by radiographic evidence. Senile atrophy, which is not directly associated with advanced age, and localized periodontal lesions with a general alveolar resistance, which present a favorable prog-

nosis for conservative treatment, can be determined by truly diagnostic radiographs.

Septic crypts around erupting third molars, resulting from pericoronitis, are more common and significant than the exaggerated "residual" infections in edentulous regions. The slow eruption of mandibular third molars, partially covered by gum folds, creates a breach in the integrity of the oral mucosa which predisposes to bacterial invasion and the establishment of a chronic suppurative gingivitis and rarefying osteitis. Dentists are usually oblivious to conditions around third molars unless acute exacerbation occurs, then apply only palliative treatment until the inflammatory symptoms subside, without investigating the osseous involvement. A large proportion of these septic crypts exist in a region prone to infection by extension, without sufficiently pronounced local symptoms to demand removal of the teeth. They can be revealed only by thorough radiographic examinations.

Because of the importance of caries in the destruction of teeth, and since they are the chief source of complications from pulpless teeth, the responsibility which radiologists share with dentists must be emphasized. Periodic clinical examinations are not effective in discovering caries before serious damage occurs, they must be supplemented by radiographic examinations. Since periodic radiodontic service is not usual, the infrequent examinations must be made to render all possible preventive service. This especially includes the detection of caries in the approximal surfaces of teeth. Radiographic evidence of caries has not been given the deserved study and is not as easily obtained or interpreted as is generally believed. The size of the posterior teeth obscures the decalcification, the irregular superimposition of the enamel causes misleading radiolucencies and the zone between the alveolar process and the enamel produces the cervical radiolucency which is

# NASAL ACCESSORY SINUS DISEASES CLINICALLY AND ROENTGENOGRAPHICALLY CORRELATED<sup>1</sup>

By L. W. DEAN, M.D., St. Louis

NOT long ago we passed through what may be described as the Surgical Age of nasal sinus disease. Numerous unnecessary operations, many of them detrimental to the patient, were performed, at least a part of them due to the fact that a proper relationship did not exist between the otolaryngologist and the roentgenologist. From the surgical standpoint too much stress was laid on the x-ray picture signs and symptoms were not correlated with the x-ray plate. This was not the fault of the roentgenologist, perhaps it was due in part to the tendency to teach surgical procedure without stressing physiology, pathology, and diagnosis. Otolaryngology does not differ from any other branch of medicine in its relation to the x-ray service.

The primary factor in the proper examination of the patient is the history, a statement which may be illustrated by the following case. A boy, 12 years of age, developed in August what seemed to be a terrific infectious pansinusitis. What appeared to be thick white pus poured from each nostril. The x-ray examination was made early in the study of the case. All the sinuses were seen to be cloudy. An immediate radical operation was advised. For some reason or other it seemed advisable to go over the patient again. In the second examination, considerable attention was directed to the securing of a meticulously exact history. Certain outstanding facts were elicited. First, the onset of the acute condition occurred on a dry hot day in July, the patient had had two previous attacks both in hot weather, he was practically free of trouble during midwinter. A cytological study was made of his nasal discharge which was found to

contain 50 per cent eosinophils and only an occasional polymorphonuclear neutrophil. In spite of the fact that the nasal discharge was typical of macroscopic pus, a different recommendation was made, namely, that the patient leave the laryngologic service and enter the allergic service.

As the result of withholding milk from the diet the clinical condition of the patient rapidly improved and in four months' time the roentgenologist expressed the opinion that the x-ray plates showed almost perfect healing. This is not an unusual result; it occurs often when one devotes at least twenty minutes to the securing of the history. A good history may bring to light a correlation of facts and takes precedence over either clinical or laboratory examination.

To me it seems obvious that a cytologic examination of the nasal and otologic discharges should be made in every case in which these conditions are present. The chest man would not think of neglecting a cytologic examination of the sputum; the genito-urinary man always makes a careful microscopic study of the urine; the cytologic examination of the nasal discharge is just as important. The presence of polymorphonuclear neutrophils in the discharge taken from the neighborhood of the ostium of a sinus means one thing, the absence of cells means another. An abundance of mucus in the discharge from the sinus has prognostic significance. Certainly it is of great importance to have information regarding the number of eosinophils present in this discharge. I should certainly feel that any examination of a nasal case was incomplete if it did not show what cells were present in the nasal discharge. Such an examination would reveal that many a so-called common

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

treatment can be given in an effort to save the life and usefulness of the tooth. Notwithstanding the superiority of American mechanical dentistry, there is no bridge that is as effective as the tooth it supplants. One tooth may be removed, but frequently two others are put in jeopardy when the bridge is attached.

Another point which he makes is the interpretation of the juxtaposition of caries to the pulp to determine if the filling, inlay, or whatever treatment may be used, is a menace to the health of the pulp. In this connection, the examination of teeth with inlays and synthetic fillings, to determine whether a beginning or advanced pulpitis is present, will contribute a most important finding in an effort to clear up foci of infection that are etiologic factors in the production of systemic diseases.

In the x-ray examination of teeth, there is one point that I desire to emphasize—do not depend upon the so-called interproximal film. A bite wing visualization is as devoid of essential information as mere examination of the stomach and duodenum is in studying the gastro-intestinal tract. If the small intestines and the colon are not visualized, you have an incomplete examination. If the periodontal structures, the apices, and adjacent alveolar structures are not visualized, you have an incomplete examination of the teeth. Dependable interpretations demand sufficient x-ray information upon which to base an interpretation.

Dr. Simpson's comments on vitality testing, in connection with the evaluation of x-ray films, were necessarily brief. I hope every radiologist understands the importance of transillumination and pulp-testing in connection with inspection of x-ray films. These are essential in locating foci of infection and interpreting these foci in terms of clinical medicine, surgery, and dentistry.

Failure to discover incipient periodontal infection leads to many errors in interpretation.

Many physicians and surgeons get the impression that, when a granuloma or a radiolucent apical area is visualized, the focus of infection has been located. But the granuloma may be comparatively harmless in the production of systemic diseases when compared with a vital tooth, the findings of which are shown in technically good visualizations of the periodontal areas.

The Doctor touches the pyorrhea question. In this connection I suggest that the members of this Society consider, for purposes of study, the tooth as being somewhat similar to a joint—that pyorrhea resembles an arthritis, and that the alveolar pathogenesis resembles an osteitis or osteomyelitis—and apply the same principles to the interpretation of teeth and their adjacent structures that are applied to roentgenograms of other osseous structures.

My time for discussion will permit of only a reference to a technic for visualizing the alveolar structures that are beyond the image projected on the intra-oral film. Dr. Simpson uses the extra-oral film and all the approved technic in his practice, in our enthusiasm in interpretation, we sometimes do not sufficiently check up our technical work.

The refinements of technic which insure the best possible quality of dental films are as essential for accurate interpretation as are the sectioning, staining, and mounting of tissue when the pathologist is to decide for or against the malignancy of a neoplasm. In solving the myriad problems of systemic disease, the opinion as to foci of infection of dental origin can be given only by one who is experienced in interpretation and who has the best quality of film upon which to base his interpretation. Dr. Simpson has emphasized that visualization should be in several angles, just as visualizations of long bones or other portions of the body are always made in as many angles as are necessary to give the correct projection of the area in question.

class of patients. On request for x-ray study I explain to the roentgenologist what points are undecided and just what information is desired. This allows him to fix his attention on certain problems and his opinion is usually responsible for the final decision. Requests for x-ray study of the sinuses by internists and pediatricians without clinical examination of the sinuses themselves are difficult to justify. Certainly in hospitals, with a large x-ray department, overburdened with work, much better service can be secured by requesting x-ray examinations only in cases in which they are indicated. Such an x-ray examination should be preceded by a thorough clinical one. Making the x-ray film first often leads to an expression of opinion to the patient which, in the final analysis, must be contradicted.

In infants and young children, the x-ray examination of the nasal sinuses should be made early in the course of the study of the case because the nasal sinuses in infants and young children are so precocious as to size. The first point to determine in such a patient

is whether or not a given sinus is present, and, if present, whether or not on an anatomical basis it has clinical significance. A sphenoid sinus at the age of five years may be 3 mm. in diameter or it may be 18 mm. in diameter. It is essential to know the size. If a patient has no frontal sinus, to know that fact early helps in the diagnosis of a head condition. For many years I practised laryngology before we had the assistance of the x-ray. My diagnoses were then made by securing a thorough history and making a meticulous clinical examination. Errors were often made. To-day the best results can be secured by continuing this old procedure and adding to it the x-ray findings.

#### SUMMARY

If the best result is to be secured, the roentgenologist must know the history of the case, the clinical findings, and if possible, there should be a personal conference between the clinician and the laboratory man in every case.

## TREATMENT OF SUPERFICIAL FUNGUS INFECTIONS WITH THE LONG WAVE LENGTH ROENTGEN RAYS (GRENZ RAYS)

### FURTHER OBSERVATIONS<sup>1</sup>

By MAURICE DORNE, M.D., and CLEVELAND WHITE, M.D., CHICAGO

THE prevalence of the superficial fungus infections ("ringworm") is now generally recognized even to the extent of being accorded second place (1) in the order of incidence of the most common skin diseases. This steady increase in prevalence during the past few years has been considered by many as only apparent, because of our better knowledge of the disease, and, as a result, our greater skill in recognizing its characteristics. However, a

careful survey of the statistics from various countries is rather convincing proof that this increase is really actual.

The increasing recognition of the importance of the superficial fungus disease has stimulated research and observation in all of its clinical and laboratory phases, resulting in numerous valuable advances, with the exception of therapy. Every dermatologist in particular, and all clinicians in general who treat these cases, has his own favorite remedy, with the result that innumerable drugs, almost every available therapeutic physical agency, and various combinations of different methods have met with but partial suc-

<sup>1</sup>Read before the Pathological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1911.

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cold is an allergic matter and not an infectious process. In one instance the presence of carcinoma cells in the washings from the maxillary sinus resulted in a diagnosis of carcinoma of the maxillary antrum. In this instance neither the history nor x-ray examination was suggestive of malignancy.

In 1931 C. S. Linton conducted, in the Oscar Johnson Institute, an investigation of the noses of 100 patients chosen at random, whose history did not suggest any nasal disease (50 children and 50 adults). It is interesting to note that in the cases in which pus cells were found some unsuspected nasal infection was discovered. In one adult and in one child a large number of eosinophils were found, the adult was asthmatic while the child had no allergy so far as his history was concerned but his mother and two brothers were at that time suffering from manifest allergic trouble.

At the same time a routine bacteriologic study was made on the same patients, using a double glass sleeved instrument devised by C. S. Linton. I think for the first time the bacteriologic study was made of the nose from the region of the ostia of the sinuses without the swab being contaminated as it passed through the vestibule. Most bacteriologic examinations of the nose are really examinations of the air in which the patient lives because in introducing the swab it is contaminated by contact with the walls and structures in the vestibule where organisms collect from the inspired air. A most interesting finding should be credited to E. Dixon, namely, that in the normal nose in summer, at least, the mucous membrane in the neighborhood of the ostia of the sinuses is usually sterile. Previously, Linton had shown the normal nasal sinus to be sterile as a usual thing but that occasional clouds of organisms enter the sinus, to be quickly expelled or inhibited in their growth. These observations show that bacteriologic examinations when properly made without con-

tamination of the swab, are, together with the cytologic examination, most important factors in differentiating between an infectious and a non-infectious process in the sinuses.

The clinical significance of routine examinations of the otologic discharge is not so definite as in the case of the nasal discharge. For several years, we have been making at Washington University, routine cytologic examinations of the nose, while for only a few months have we studied the cytology of the otologic discharge in every case. It has been found to have much significance in evaluating the findings with the x-ray. For instance, if the x-ray plate shows one mastoid markedly involved and the other mastoid not so much so, with an equal number of pus cells in the discharge from each ear, the findings will have a definite bearing on the need of a bilateral operation. Again, when repeated x-ray plates show little or no change, a decrease in the number of pus cells, together with an increase in the degeneration of the cells, carries prognostic significance. Naturally the bacteriologic examination of the fluid secured at the time of myringotomy is of greatest importance. The presence of *Pneumococcus*, Type III with its capsule always influences us not to lean too heavily on the x-ray findings.

The pathology of the nasal sinus in allergy and in nephrosis is such that the differentiation cannot be made by the x-ray examination. In each instance the thickening of the sinus lining is due to edema, that is, providing infection has not already begun. The only way to determine when an allergic sinusitis or a nephrosis becomes an infectious sinusitis is by making a careful cytologic and bacteriologic study of the nasal discharge.

In older children and in adults the x-ray examination is of the greatest assistance in clearing up obscure points regarding the pathology. It always comes first with this

tosis of the acute vesicular or vesico-pustular type, and the chronic intertriginous type respond much better to properly administered dermatologic treatment. This is also true of the hyperkeratotic type. Some cases, however, do well under fractional x-ray treatment. Fractional doses are advisable because

(a) Inflamed tissue is hypersensitive to x-rays,

(b) The susceptibility is increased by the previous use of strong topical remedies,

(c) It has been found that if the eruption will yield to x-rays, it will respond to small doses.

If the eruption does not disappear as a result of such treatment over a period of from four to six weeks, it is unlikely to be favorably influenced by further treatment.

Filtered radiation is not believed to be more efficacious than are unfiltered x-rays.

#### EXPERIENCES WITH THE GRENZ RAYS

As stated in our previous communication (7), we employed a special generator for long wave length roentgen rays, which delivered a maximum of 12 K V and 12 ma, and which was used to activate a specially constructed modified Coolidge tube with the Lindemann glass window situated on the under surface and the entire tube encased in a metal water jacket. With this particular apparatus we were able to produce a mild red blush on the flexor surface of the forearm in a young brunette adult within twenty-four hours, employing the following factors: 8 K V, 6 ma, 3-inch skin-tube distance and one minute exposure.

Having determined the erythema dose with our particular apparatus (8 K V, 6 ma, 3 in., 1 min.) we decided to use the fractional method of treatment adopted one erythema dose as a working unit with treatments divided into one-quarter units or fraction thereof given at weekly intervals and four treatments constituting a series. This method of procedure was decided on in view

of the fact that we had limited our work to the treatment of the superficial fungus infections, using such fractional doses at weekly intervals, so that there could hardly be any question as to the safety of the dosage. A few cases have been demonstrated by several dermatologists in which damage to the skin has been produced by erythema doses of Grenz rays. In cases in which large areas were involved, necessitating repeated focusing at each treatment, the dosage was reduced one-half. In several instances, as in the treatment of the nails, the dosage at each treatment was doubled.

In several of our patients, a single one-quarter unit exposure provoked a reaction which was manifested by an aggravation of the original lesions. In most instances these reactions subsided spontaneously within forty-eight hours, with a resultant improvement in the lesions. In one instance the reaction occurred after the second treatment, the first treatment apparently having improved the condition. As the dosage employed in the treatment of all these patients was identical, it would seem that the reactions induced were the results of individual tolerance. In several instances following a series of treatments, there were recurrences of the original lesions. These were always milder than the original condition and responded promptly as a rule, to the one or two additional treatments.

The first patient treated was a male, 33 years of age, who had a tinea cruris of five years' duration. The case cleared up entirely with one treatment of a quarter unit to each area. The next three cases failed to respond even after three treatments had been administered. At this point in our investigation, a complete check-up of our apparatus revealed the fact that it was functioning properly. Following this experience it was decided that a clinical diagnosis alone was not sufficient indication for this type of treatment and routine smears (the

cess, tending to reveal the refractoriness of this disease to treatment

The rapidly accumulating literature on Grenz-ray therapy, even to this date, has failed to reveal any concerted effort in the treatment of these infections, regardless of the fact that they are primarily localized in the epidermis and that most of the radiation of Grenz rays is absorbed by the epidermis and upper layers of the derma. It was felt that if the Grenz rays offered any possibilities in the dermatologic domain, one excellent opportunity to determine this was in this particular field, and so it was decided to give this method a thorough clinical trial

#### ETIOLOGIC ASPECTS

Research into the etiologic aspects of the superficial fungus infections has revealed the fact that the manifold cutaneous expressions may be the result of the action of all three classes of micro-organisms—hyphomycetes, yeasts, and bacteria (2)—with the yeast assuming a greater importance than either of the others

The efforts to classify fungi satisfactorily have resulted in considerable confusion, different workers often using different bases. Therapy has suffered as a result of this, for a simple classification based on the major morphologic characteristics might be of far greater value to the clinician and lead to better therapeutic results

For practical purposes, as related to the subject under discussion, we have classified the fungi into two groups, namely, hyphomycetes and yeast-like fungi. In the latter group hyphae may be present both microscopically and in culture. These fungi unusually present the round-cell yeast structure. This classification is used advisedly, for Draper (3) has demonstrated that the yeast forms will grow mycelia by certain changes in the medium

Predisposing factors in these fungus infections have attained a position of importance as is reflected by the special attention

given them. Hyperhidrosis is now generally admitted as an important predisposing factor, and Levin and Silvers (4) obtained cultures of apparently pathogenic fungi from the sweat in five of eight cases. Pre-existing intertrigo and plantar dysidrosis may predispose to infection with fungi, so that these possibilities must not be overlooked in therapeutic management. A much disputed point at present is the possible etiologic relationship of yeast forms in dermatitis of various types and one of us (C W) (5) has performed a series of successful inoculations of fungus cultures on their respective hosts, indicating a possible pathogenicity in the syndrome known as seborrheic dermatitis, especially of the exudative type and in certain types of infantile eczema

#### X-RAY RESULTS AND ATTENDANT DANGERS

Practical skin therapy with the x-rays has been developed by dermatologists such as Sabouraud, Pusey, MacKee, and others. If judiciously applied, it is an extremely useful agent in dermatologic practice and is now considered by many as the most useful and successful single remedy available for the treatment of skin diseases. While it is true that the x-rays have proven themselves almost specific in the treatment of various cutaneous disorders, they have failed almost completely in others. They cannot be considered a panacea for all skin diseases

The superficial fungus infections have proven themselves even more refractory to irradiation than to other forms of therapy. Occasionally the infection is permanently cured, very often after the subsidence of the acute symptoms no further improvement is noted. Recurrences are common. It is more or less generally agreed that the majority of the cases will do better under intelligent antiparasitic treatment than under irradiation. Nevertheless it is often of value as an adjunct

According to MacKee (6) dermatophy-

Case	Age	Sex	Areas of Involvement	Clinical Diagnosis	Mycologic Findings KOH Cultures	Treatment with Grenz Rays	Clinical Results
17	12	F	1 left thumb and index right index and middle fingers	Epidermomycosis	KOH ++, yeast	3 - 1/4	Improved, did not return
18	13	F	Scalp, face neck, arms	Seborrheic dermatitis and epidermomycosis	Repeatedly negative for fungi	7 1/4	Very marked improvement, much treatment preceding Grenz
21	12	M	Feet and generalized eruption	Epidermomycosis and epidermomytid	First KOH and cultures con- taminated Later KOH and cultures +++ yeast	7 - 1/4	All cleared
22	11	F	Dorsum of toes and feet	Epidermomycosis	KOH and cultures +++ for yeast	1 - 1/4	Marked improvement
21	12 Pregnant	F	Toes, both feet, finger nails	Epidermomycosis	KOH and cultures +++ for yeast	2 1/4	Improved
21	10	F	Third digital interspace, right hand	Erosio interdigitalis blastomycetica	KOH and cultures +++ yeast with fermentation	4 1/4	Markedly improved
25	14	F	Toes of left foot	Epidermomycosis	KOH and cultures +++ for yeast	5 1/4	Entirely cleared
29	10	F	Web between middle and ring fingers, right and left	Erosio interdigitalis blastomycetica	KOH and cultures +++ for yeast	3 1/4	Right treated with methyl- violet, left with Grenz right much better, both im- proved
30	20	M	Toes and feet	Epidermomycosis	KOH +++ yeast	1 1/4	Improved
32	13	M	Feet and toes	Epidermomycosis	KOH negative cultures +++ yeast	2 - 1/4	Improved
31	21	M	Both feet	Epidermomycosis	KOH negative cultures— monilia	1 1/4	Improved
35	30	F	Fingers	Epidermomycosis	KOH and cultures +++ monilia	2 - 1/4	Marked improvement
36	38	F	Toes, left foot	Epidermomycosis	KOH and cultures negative	2 - 1/4	Improved



TABLE I

Case	Age	Sex	Areas of Involvement	Clinical Diagnosis	Myecologic Findings KOH - Cultures	1 treatment with Grenz Rays	Clinical Results
1	26	M	Intragluteal fold	Pruritus ani	KOH and cultures +++ , yeast-like fungi	$\frac{1}{4}$ unit	Cleared of symptoms in 72 hours
2	31	M	Fingers, left hand	Epidermomycosis	KOH and cultures +++ , yeast	$\frac{1}{4}$ unit $\frac{1}{4}$ unit	Cleared recurred in 3 weeks, cleared entirely
3	38	F	Intragluteal fold	Pruritus ani	KOH and cultures negative	$\frac{1}{4}$ unit	No improvement, did not return
4	31	M	Palm of right hand right fingers	Epidermomycosis	KOH and cultures +++ , yeast like	4 $\frac{1}{4}$	All cleared
5	30	M	Both axillae, marked gentoocrural, slight	Epidermomycosis	KOH ++ yeast like	3 - $\frac{1}{4}$	Five months previous 4 x ray treatments to axillae and 2 to gentoocrural, no im- provement, markedly im- proved by final treatment
6	26	M	Fingers and both hands to wrists	Dermatitis venenata with secondary superimposed mycotic dermatitis	KOH ++ , yeast like	0 $\frac{1}{4}$	All cleared
7	30	M	Fingers and hands with toxic eruption from hands on neck	Dermatitis venenata with secondary superimposed mycotic dermatitis	KOH ++ , yeast	4 - $\frac{1}{4}$	All cleared
8	20	F	Scalp face neck, axillae, gentoocrural, lower ab- domen	Seborrheic dermatitis and mycotic dermatitis	KOH ++ yeast	8 $\frac{1}{4}$ to all areas	Cleared after 3 x ray treat- ments, recurrence, addi- tional Grenz did not help much, other treatment
9	11	F	All fingers of both hands	Epidermomycosis	KOH ++ yeast	4 - $\frac{1}{4}$	Marked improvement did not return
10	20	F	Palms and index and middle fingers left hand	Dermatitis venenata with secondary superimposed mycotic dermatitis	KOH ++ yeast	3 $\frac{1}{4}$	All cleared

# ESTIMATING THE RISK OF OPERATIONS ON THE BILIARY TRACT BY TESTING THE EXCRETORY FUNCTION OF THE LIVER<sup>1</sup>

By EVARTS A. GRAHAM, M.D., St. Louis

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IN 1918, observations were published by the writer (1) which indicated that, in every case of cholecystitis, there is an associated hepatitis. The inflammation, which is more marked in the right lobe than elsewhere, seems to be essentially an infection of the lymphatics around the small intrahepatic bile channels. This work has now been corroborated by many others, notably by Heyd (2), by Moynihan (3) and by Flint (4). In those cases in which jaundice is associated with cholecystitis, but without demonstrable obstruction of the common bile duct, it seems probable that the jaundice is due to an obstruction of the intrahepatic bile ducts caused by the type of inflammation which has just been mentioned. The fact that an actual hepatitis can be demonstrated to be practically a constant accompaniment of cholecystitis shows that the possibility of the presence of a damaged liver must always be taken into consideration when dealing with a case of inflammation of the gall bladder.

We are just beginning to appreciate the great importance of the liver as the origin of some unexplained deaths after surgical operations, although for a long time we surgeons have hesitated to operate on patients who have badly damaged kidneys. In a sense, however, the liver is more important to us than our kidneys, because life will not go on more than a few hours without the liver but we can live for about a week without any kidney tissue. When Richard Bright nearly a hundred years ago, found that the urine from a certain patient coagulated when boiled in a test-tube over a spirit

lamp, he unconsciously made a great contribution to our methods of lowering operative mortality. The crude method of Bright has been supplanted by the more refined methods which we now possess of estimating how the kidneys perform.

If we had methods at our disposal for determining, to the same degree of satisfaction, the functional activities of the liver as those which we have for the kidneys, we would undoubtedly be able to reduce the present operative mortality to a still lower point. At the present time, we do not even know what all of the functions of this important organ are, and we do not have satisfactory methods of measuring those functions with which we are acquainted. There are many patients who die unexpectedly after surgical operations whose deaths cannot be adequately explained. Some deaths are considered to be of cardiac origin, some are ascribed to shock, and some to pneumonia, which, however, may at times be shown at autopsy to be negligible in amount. If we had a clearer understanding of the functions of the liver, and if we had more accurate methods of estimating those functions, we would probably be amazed to discover how often a damaged liver plays a rôle in the various conditions to which we now give other names as causes of death.

When, in our early work on cholecystography, we changed from tetraiodophenolphthalein (iodeikon) to phenoltetraiodophthalein (iso-iodeikon), we found that we had a substance which, when injected into the blood stream, not only caused visualization of the gall bladder but also stained the serum upon the addition to the latter of a little alkali. Therefore, the substance could

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

extemporaneous potassium hydroxide preparation) and cultures (Sabouraud's dextrose mediums) were included in every case. As a result of this routine examination we soon learned that the cases which were positive for monilia and yeast-like fungi responded with good results, while the infections of hyphomycetic origin showed very little if any improvement.

In our original communication (7) we reported 30 cases, to which we now wish to add 22 more. In this latter group our experience has been quite identical with that of the former group reported. Two of the patients in this latter group were cases of *erosio interdigitalis blastomycetica*. The lesions in both instances involved the third interspace on both hands. Potassium hydroxide preparation and cultures revealed yeast. In one instance topical applications consisting of 0.5 per cent methyl-violet aqueous solution was applied to the lesion on one hand once a week and a one-fourth unit of Grenz ray was given to the lesion on the other hand once a week. It was very interesting to note that improvement occurred in the lesions after two treatments by both methods and somewhat more marked in the lesions treated by topical applications.

In this connection, however, the important observation was the fact that yeast was recovered from the lesions and there was a prompt response to therapy, whereas in our original communication we reported an instance in a woman, aged 59, with similar lesions, in which the potassium hydroxide preparation revealed large branching hyphae, but cultures were negative. There was no improvement after four quarter-unit treatments with the Grenz ray and the patient thought the condition was aggravated if anything.

This substantiates our original observations that good results were obtained in the

patients who had infections due to yeast-like fungi, while the infections of hyphomycetic origin showed very little if any improvement.

Experiences with occupational dermatoses complicated by secondary superficial fungus invasion are too meager to permit any fair evaluation at this time.

#### CONCLUSIONS

An experience of 22 more cases is added to a previous report of 30 patients who had dermatoses considered to be of superficial fungus infection and were treated with the Grenz rays used in fractional doses.

With such dosage those due to yeast-like fungi responded quite uniformly to therapy, while those of hyphomycetic origin showed very little if any improvement.

Further investigation is being actively pursued to determine the full worth of the above observations.

We wish to thank Dr. A. W. Stillians and Dr. J. S. Coulter for their many kindnesses which made it possible for us to study these cases and to have access to departmental facilities, also, Miss Bertha Culka, who has aided us greatly by performing all the culture work.

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experimentally that the recovery of livers damaged by carbon tetrachloride was greatly hastened by the use of small amounts of calcium

We set a retention of 50 per cent as an arbitrary standard upon which to base our decision whether or not to postpone operation. Experience showed us that, in several cases when the dye retention was even as high as 90 per cent, it could be brought down to about 30 per cent by a course of treatment such as that just outlined. The patient then was a suitable risk for operation, as shown by the results obtained.

There is probably no particular virtue in the use of iso-iodikon for this purpose, undoubtedly any of the dyes which are excreted, for the most part through the liver, could be used. It is likely, however, that it may be necessary to use these dyes in larger doses than has been customary in cases in which they have been used in the past for purposes of diagnosing a particular lesion or condition of the liver. Most of the dyes which have been used for tests of hepatic function have been used in doses which were probably too small to give suitable information. On the other hand, a dose of iso-iodikon of 2.5 gm., which is necessary for cholecystographic purposes, is about eight times the dose ordinarily recommended for most of the other dyes that have been used for testing hepatic function.

We have noted a striking reduction in our operative mortality in cases of disease of the biliary tract since we have begun to pay attention to the information provided for us by testing the excretory function of the liver. For example, in the three-year period before the recognition of the importance of carrying out this test, our average mortality in cases of simple cholecystectomy was 6 per cent in 216 cases. In the last three years, our mortality has dropped to 0.5 per cent in 224 cases of simple cholecystectomy. At the same time, a striking reduction has also occurred in the mortality following operation

on the common duct, namely, a drop from 7.7 to 2 per cent. The following table illustrates in a striking manner the decline in mortality which has occurred in cholecystectomy since using the information obtained by the test of hepatic excretion.

#### HOSPITAL MORTALITY AFTER CHOLECYSTECTOMY

For Three Years Preceding Use of  
Phenoltetraiodophthalein

Year	Cases	Deaths	Percentage
1925	78	4	5.1
1926	63	7	10.1
1927	75	3	4.0
Total	216	14	6.5

For Three Years during Which Test has been Used

Year	Cases	Deaths	Percentage
1928	90	0	0
1929	68	0	0
1930	66	1	1.5
Total	224	1	0.5

There has been no difference in the type of patient operated on in the last three years compared with that operated upon in the previous three years, except for the matter of the excretory function of the liver. In other words, except that we have postponed operation on patients who showed a high retention of the dye, we have made no other selection. In only one instance have we refused operation and that was in a patient of advanced years who had a bad myocarditis with decompensation, angina pectoris, and marked arteriosclerosis.

All of us have been so forcibly impressed with the possible importance of tests of excretory function of the liver in estimating the operative mortality that we feel it is applicable probably to all operations and not merely to those on the biliary tract. Up to the present time, however, we have convinced ourselves by a study of this question only with reference to the latter, which seem to present the best possibility of gaining information on this point because of the well known association of hepatic disease with diseases of the biliary tract.

Of course, all deaths after operations on

be used for studying the liver function in the same manner as had been proposed for phenoltetrachlorophthalein in the Rosenthal test. Of course, a simple dye test can hardly be expected to give information on the many and varied functions of the liver, but it can give us information on the ability of the liver to excrete that particular substance. It may, therefore, correspond in some measure to the tests of the excretory function of the kidney. As we have continued to make observations on the rate of excretion of phenoltetraiodophthalein in cases of disease of the biliary tract in which operation is contemplated, we have become more and more convinced that even these crude estimations of the hepatic excretory function are of decided value in estimating the operative risk.

A few years ago, shortly after beginning the use of phenoltetraiodophthalein (isoiodeikon), we happened to have four unexpected deaths after simple cholecystectomy. The deaths occurred in patients who apparently were good operative risks. At autopsy, in none of these patients could an adequate cause for death be found except a badly damaged liver. In seeking a possible explanation of the tragedies, we reviewed all the particulars of the cases and we found that in each one there had been a high retention of the dye. Whereas in the normal individual there is a retention of from 10 to 15 per cent of the dye within a half-hour, two of the four patients just mentioned had retentions of 90 per cent in the half-hour, one of 70 per cent and the fourth of 60 per cent. The significance of these findings seemed striking especially when we found that those patients who did not have high retentions of the dye went through their operations in a thoroughly satisfactory manner. Additional support to the belief that these patients had serious hepatic disease was brought by the fact that small pieces of liver removed at operation showed, on microscopic examination, extensive hepatitis.

For a good many years it has been my custom when performing an operation on the biliary tract, frequently to remove a small piece of liver for microscopic examination. Fortunately, in these four fatal cases small segments of liver tissue were available for examination. They had been promptly placed in fixing solution and were essentially, therefore, living tissue. The changes noted could not have been due to postmortem autolysis—they consisted chiefly of extreme cloudy swelling, together with some edema. In addition there were evidences of periportal inflammation of the same sort which is found characteristically in all cases of cholecystitis. In other words there appeared to be a very definite correlation between the high retention of the dye in each case and the presence of marked histologic changes in the liver.

After discovering that an apparent relationship existed between the amount of retention of the dye and the safety of operation on the particular patient we decided that, in the future we would not operate upon patients who showed a high dye retention. Instead of operating, we proposed to put such patients at rest for two or three weeks on a diet rich in carbohydrates. This was done with the idea of insuring the storage in the liver of a large amount of glycogen, since it is well known that the functions of the liver depend to a considerable extent upon the amount of hepatic glycogen. If the patients were unable to tolerate much carbohydrate by mouth glucose was administered intravenously. An effort was made to provide the adult of ordinary size with approximately one hundred grams of glucose in 24 hours. In addition carrying out an idea first published by Lamson Mott and Robbins (5) small amounts of calcium were administered in the form of calcium lactate. This was done not because of any relationship to the question of the coagulation of the blood but because these workers found

# EDITORIAL

LEON J. MENVILLE, M.D.

Editor

BUNDY ALLEN, M.D.

Associate Editor

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## PANCREATIC LITHIASIS

The advent of the roentgen ray has made possible the accurate diagnosis of calculi of various organs of the human body. So much so that an examination of the genito-urinary and biliary tracts is not considered complete without a roentgen examination. There is an abundant literature on the diagnosis of the different types of calculi with the roentgen ray, with the exception of pancreatic calculi, while comparatively few reports are to be found regarding the part which the roentgen ray plays in the diagnosis of this condition. It is to be appreciated that pancreatic calculi are considered uncommon, nevertheless, when we consider the chemical composition of such calculi and the size they sometimes attain, it seems that roentgenologists are overlooking a certain percentage of them.

Regnerus de Graaf, in 1664, reported the first case of pancreatic lithiasis. Lazarus, in 1903, was able to collect only 80 cases in the literature during the period of nearly two and a half centuries following de Graaf's report. Most of the cases reported by Lazarus were found at the autopsy table.

In 1906 Zesas was able to collect only 7 cases of pancreatic calculi diagnosed during life. In more recent years an increasing number have been reported due in a large measure to the accuracy of diagnosis with the roentgen ray. Hess and also Seeger of this country have reported interesting cases of pancreatic calculi diagnosed roentgenologically. Many others have made similar

reports, among whom are Lindsay, Jacquelin and Quenu, Morrison and Bogen, Zulschwerdt, Gross, Wolf and Tietze, Haudek, Friedrich and Hoesch, Orth, Ohnell, Senett, and others.

The chemical composition of pancreatic calculi is of sufficient density to cast a shadow on an x-ray film, in fact, comparable with calculi of the biliary and genito-urinary tracts. They consist chiefly of calcium carbonate or calcium phosphate or even, occasionally, calcium oxalate, all of which have a sufficient absorbability rate to cast a dense shadow. Calcium phosphate, calcium carbonate, and calcium oxalate calculi are commonly found in an examination of the genito-urinary tract by means of the roentgen ray. Calcium phosphate and calcium carbonate calculi are also frequently found in a similar examination of the biliary tract. Therefore, pancreatic calculi should—and do—cast intense shadows as dense as those found in the biliary and genito-urinary tracts. The approximate absorbability rate of calcium phosphate ( $\text{Ca}_3(\text{PO}_4)_2$ ) to the roentgen ray is about 547.038, calcium carbonate ( $\text{CaCO}_3$ ) about 141.939, and calcium oxalate ( $\text{CaC}_2\text{O}_4$ ) is about 151.158. All three types of calculi have a high absorbability rate, and, unless they exist as mere sand in the pancreas, should be visualized without much difficulty.

Of particular interest to the roentgenologist is the fact that rarely is a single pancreatic calculus found, the usual number being from five to ten, but as many as 300 have been found. Their size and shape vary from mere sand to that of a walnut, some are smooth and others rough, some soft and others hard and unlike gallstones, they are seldom faceted.

At times pancreatic calculi are confused

the biliary tract are not due to disturbances of hepatic function, some are due to pneumonia, some to cardiac complications, and others to various other disturbances. It seems possible, however, that, if a patient has a badly damaged liver to begin with, he may become more readily susceptible to various other post-operative complications such as pneumonia, etc. At any rate, our astonishingly low mortality since utilizing the test of hepatic excretion seems to indicate that determinations of liver function, crude as they are, may, nevertheless, be important in deciding whether or not a particular patient is a suitable operative risk in much the same way that even a crude test of the urine for albumin may save the lives of surgical patients.

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#### DISCUSSION

DR JAMES T. CASE (Chicago) Those of you who know my predilection for the intravenous method of gall-bladder examination will appreciate that I am glad to hear Dr. Graham emphasize the importance of estimating the hepatic efficiency simultaneously with cholecystography, for it constitutes another argument for using the intravenous method.

DR L. R. SANTE (St. Louis) The paper by Dr. Graham marks a step forward in the diagnosis of gall-bladder and liver conditions. There still persists a certain small percentage of error in cholecystography if the function of the gall bladder does not really indicate the pathologic condition present. A portion of these is sometimes due to a defect in function of the liver. Perhaps this method of estimating the function of the liver may aid in cutting down that small percentage.

#### A NEW SUGGESTION FOR STUDYING X-RAY FILMS

By OSCAR W. BETHEA, M.D., NEW ORLEANS  
Professor of Clinical Medicine, School of Medicine,  
Tulane University

In studying x-ray films it is a common custom to use a reading glass, held more or less close to the film, and to focus it upon various areas with the object of enlarging the particular field of interest.

My suggestion is that a reading glass about five inches in diameter be so held as to cover both eyes, that it be held directly against the face of the examiner and the focus obtained by the examiner moving his face to the proper distance from the film. It will then be found that a stereopticon effect is obtained and almost a suggestion of a third dimension.

I have submitted this plan to a number of

outstanding roentgenologists and they tell me that, so far as they know, this recommendation has not been offered previously. A manufacturer of optical instruments has written me as follows: "We find that your recommendation has much value from the medical practitioner's standpoint. We sincerely believe that [they will] appreciate a knowledge of this because it does offer a definite advantage in studying the film."

The only drawback is that the proximity of the glass to the face may result in a fogging of the lens. If this plan is found of sufficient value, it is possible that some manufacturer will make what will correspond to a transverse strip of reading glass attached to a headband or, goggles might be so made that the lens would represent the same areas of the magnifying glass that are used when the latter is employed as a whole.

the close of the session The essayists will be grouped

Further information concerning round table discussions will be placed on the bulletin board, at the information desk, and announced at the close of the sessions

The entire business of the Congress and the organizations sponsoring it will be conducted from a single registration desk For this purpose Spaces 1 to 5 at one end of the hall of technical exhibits has been reserved Various clerks will be stationed at this desk, each being identified as to which society she is serving

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### MICROSCOPIC, ORAL CAVITY, AND BONE DEMONSTRATION

This is a preliminary notice of a Microscopic, Oral Cavity, and Bone Demonstration, with lantern slides, at the Mayflower Hotel, Washington, D C, September 17 to 24, inclusive

Thanks to the courtesy and interest of my friend and patient, Mr R L Pollio, Manager, the minimum American plan rate will be \$4 50 per day, per person, for a large room or parlor suite occupied by three persons, including bath and three meals per day, or for those desiring rooms with twin beds and bath, occupied by two persons, with three meals per day, \$5 00 All those desiring European plan rates must write directly to Mr Pollio, who will quote them

We are changing from Baltimore to Washington because of the artificially cooled demonstrating rooms given to us without cost, and also for the artificially cooled dining room and these especially low rates, with no change in the service of the hotel

I am very anxious to attract to this Demonstration in Washington a larger number of pathologists radiologists surgeons, dentists, and physicians interested in the diagnosis and treatment of cancer in all stages and the local conditions that precede cancer

All the Demonstrations will be diagnostic Lantern slides will be shown first, and everyone will be given an opportunity to record his diagnosis before it is given There will also be a discussion on pre- and post-operative irradiation

I would advise you to arrive, if possible, Sunday afternoon, as there will be a conference Sunday afternoon on the problem of pre-operative irradiation Monday, the 18th, will be devoted to the microscopic lantern slide demonstration, Tuesday, Wednesday, and Thursday, the 19th, 20th, and 21st, to the regular bone demonstration, Friday and Saturday, the 22nd and 23rd, to the oral cavity demonstration The microscopic lantern slide demonstration will be chiefly a review of the sections in the loan collection, with special relation to the biopsy of the breast, cervix, and lymph glands

It is essential for Mr Pollio to know, as soon as possible, the number who expect to come and who want the minimum American plan rate This demonstration cannot be given until 100 accept the minimum American plan rate The maximum to be accommodated in the cooled demonstration room is 750

Anyone who wishes to present a case will please notify Dr Charles F Geschickter, Johns Hopkins Hospital, Baltimore All that is necessary is that the case be put in lantern slides

Immediately write to Mr R L Pollio Mayflower Hotel, Washington, D C, registering for the accommodations desired Please drop me a postal letting me know if you can come It would be a great help to us if you would tell such of your colleagues as may be interested in this meeting, give them the invitation and send me their names and addresses

Very sincerely yours,

JOSEPH COIT BLOODGOOD, M D



with renal calculi, calcified glands, or biliary calculi, but by careful roentgen-ray examination and by process of elimination, there should be but little difficulty in making a correct interpretation. On the other hand, many interesting cases have been reported that show the importance and accuracy of roentgen-ray diagnosis. In a case reported by Hartman, an examination was made with the roentgen ray following the removal of pancreatic calculi at operation, and revealed stones which had been overlooked.

No doubt because of the epigastric pains so commonly associated with pancreatic calculi, cases are at times referred for roentgenologic examination of the gastro-intestinal tract. In such instances, they are often overlooked due to the bariumized meal overshadowing the pancreatic region. Perhaps many more cases would be diagnosed if scout films were made in all gastro-intestinal and genito-urinary examinations before the administration of the opaque substances commonly employed in such examinations.

Although the most important and constant symptom is pain in the epigastrium, cases have been reported in which the patient had never had any pain. Lazarus reported such a case, in which, at necropsy, the pancreas was found to have been converted into a fibrous sac, and, notwithstanding the fact that the duct contained numerous jagged concretions, there had been no pain. Wolf and Tietze report a case of a man who had never had any colic and his only complaint was intense hunger and the passage of bulky stools. Roentgenologic examination revealed pancreatic calculi. There are, on the other hand, cases reported in which the roentgen-ray examination was negative and yet calculi were found at operation or at necropsy.

The roentgen ray is at present considered an indispensable factor in detecting pancreatic calculi and we should constantly be on the alert in our search for them. It is reported that serious complications may be oc-

casioned by their presence. Because of this, and also because of the varied symptomatology of this condition, the roentgen ray should be frequently used in vague upper abdominal complaints, keeping in mind pancreatic calculi as a possibility.

## ANNOUNCEMENTS

### AMERICAN CONGRESS OF RADIOLOGY

#### ANNUAL MEETING OF THE SOCIETY

As a last word, the annual meeting for 1933 will be held at the Palmer House in Chicago in conjunction with the First American Congress of Radiology. The four radiological organizations, the American College of Radiology, the American Roentgen Ray Society, the American Radium Society, and the Radiological Society of North America, are sponsors for this Congress. The interest of all radiologists will be focussed on this Congress. A large attendance is insured by the facts that it is held during 'A Century of Progress,' that the four radiological organizations have combined their scientific programs and exhibits for 1933, that but one journey is required to attend these combined meetings and finally that there will be no increase of the regular rates at the Palmer House Hotel for those who attend this Congress.

The rates are single rooms with bath, \$3.50 to \$6.00, double rooms with bath, \$6.00 to \$10.00.

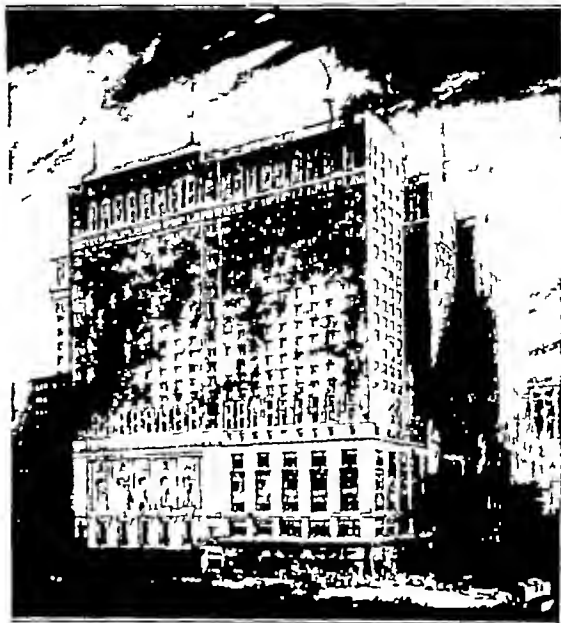
The time of the Congress will be the last week of September (September 25-30). The sessions of the scientific program begin at 9 o'clock each morning and close at 2 each afternoon. Luncheons and round table discussions will be so arranged that those who are interested may have an opportunity to meet the essayists and discuss with them the subjects they have prepared. These round table discussions and luncheon periods will begin at 2:15 p.m. immediately following

with the Congress of Radiology, which is to be held at the Palmer House, Chicago, September 25 to September 30

The publication of this letter brought forth a sufficient number of replies to indicate considerable interest, and steps toward the organization of such an exhibit were taken. In this exhibit strictly medical photography will have no part, only general pictorial photography (landscape, portrait, or genre) will be included. A committee consisting of Dr C D Enfield, of Louisville, Kentucky, Dr E A Merritt, of Washington, D C, and Dr A U Desjardins, of Rochester, Minnesota, was organized. Also, a committee of three judges, consisting of Dr F W Burcky, of Evanston, Illinois, Dr Max Thorek, of Chicago, Illinois, and Mr G H High, of the Chicago Camera Club, Chicago, Illinois, has been arranged to pass on the individual exhibits and determine the two contributors who deserve the first and second prizes. The Eastman Kodak Company have graciously offered, as a first prize, a Kodak Recomar No 33, which is equipped with an f 4.5 Anastigmat lens, Compur shutter, 3 single plate holders and film sheaths, film pack adapter, exposure table and brown cowhide carrying case to hold camera, plate holders and film pack adapter. As a second prize, they offer a Kodak Six-16, which is equipped with an f 6.3 lens, with a Diodak shutter.

The space reserved for the exhibit is naturally limited, and already nine members of the different societies taking part in the Congress have undertaken to contribute to this exhibit.

Under different circumstances, it would have been advisable to conduct this exhibit strictly according to salon rules, but inasmuch as the object of this first exhibit is to stimulate interest in the photographic side of roentgenology by leading as many roentgenologists as possible to take up photography as a hobby, it has been thought best to allow some latitude. Therefore the contributors



Palmer House, Chicago, headquarters of the Radiological Society of North America, participating in the American Congress of Radiology

will be allowed to mount, mat, or frame their prints according to their own taste.

If this first exhibit should prove as successful as it now promises to be, and if it should stimulate sufficient interest, future exhibits should be conducted according to salon rules.

A U DESJARDINS, M D, *Chairman*

### AMERICAN CONGRESS OF RADIOLOGY

#### PALMER HOUSE, CHICAGO, HEADQUARTERS

As host to thousands of visitors to Chicago this Summer, the new Palmer House is to be headquarters to the American Congress of Radiology, to be attended by radiologists from all parts of the world during the week of Monday, September 25 to Saturday, September 30. The scientific sessions as well as the commercial and technical exhibits will all be on one floor, the fourth.

For sixty-one years the Palmer House has stood as a gathering place for social and business life. Worth over two score million

## RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

The following are the present officers of the Radiological Section of the Los Angeles County Medical Society: Karl M. Bonoff, M.D., *President*, Richard T. Taylor, M.D., *Secretary*, Henry Snure, M.D., *Treasurer*.

## THE PACIFIC ROENTGEN CLUB

On June 11, 1933, a number of leading roentgenologists of California met at Santa Maria and founded the Pacific Roentgen Club, organized for the purpose of handling those problems arising in the medical profession having particular relationship to the practice of radiology.

This branch of medical practice has been adversely affected by inadequate legislation and laws which might protect it from the inroads of laymen, nurses, and corporations.

In unskilled hands, the x-ray is a potentially dangerous instrument, just as certainly as the scalpel, the hypodermic, or the anesthetic. Radiological treatment, based upon a competent and accurate diagnosis, has proved itself a boon to human health and happiness, and the use of x-radiation should be as adequately safeguarded by legislation as is the practice of any other ethical department of medicine.

The Pacific Roentgen Club objects to a condition which permits the exploitation of a legitimate physician for the purpose of profit to non-medical individuals or corporations. Under our present laws in California a corporation is not permitted to engage in the practice of medicine and this same restriction should cover the practice of radiology which in itself is a distinct and important part of medical practice. Radiation therapy, combined with adequate and expert surgery, offers the only present-day cure for malignant disease and radiologists there-

fore, should be surrounded with the same legal protection which is accorded surgery and the general practice of medicine.

The State Medical Association recognizes this fact, and the Pacific Roentgen Club plans, in co-operation with the State Medical Association, to see that incompetent and unauthorized individuals are prevented from attempting to practise radiology, with attendant dire results to the general public.

It is suggested that roentgenologists contemplating a location on the West Coast communicate with the Pacific Roentgen Club for information, before severing their Eastern connections, thereby preventing exploitation of themselves or other unhappy results as shown by past experience. Address: L. S. Goin, M.D., *Chairman*, 1930 Wilshire Boulevard, Los Angeles, California, or L. H. Garland, M.D., *Secretary*, 450 Sutter Street, San Francisco, California.

ALBERT SOILAND, M.D.

## PHOTOGRAPHIC COMPETITION

In the January, 1933, number of the *American Journal of Roentgenology and Radium Therapy* there appeared a letter, written by Dr. A. U. Desjardins, of Rochester, Minnesota, in which he attracted attention to the fact that, next to physics and electrical engineering, knowledge of photography is the most valuable asset to the roentgenologist, and in which he stressed the desirability of photography as a hobby. Many members of The American College of Radiology, The American Roentgen-ray Society, The Radiological Society of North America, and The American Radium Society have long been interested in photography, and the interest of those who practise diagnostic roentgenology is nearly always reflected in the technical quality of their roentgenograms and the accuracy of their interpretations. In this letter Dr. Desjardins also advanced the idea of organizing an exhibit of pictorial photography in connection

with intracranial disease well know The author also states that erosions of the sella turcica may be due to (1) a primary intrasellar tumor, (2) an increased intracranial pressure which has produced a secondary internal hydrocephalus, and finally (3) a malignant tumor of the hypophysis or of the sphenoid paranasal sinus He omits entirely the localized changes in the sella resulting from direct pressure incident to parasellar tumors, particularly the meningiomas and aneurysm

The subjects of ventriculography and encephalography are well presented and bespeak the author's familiarity with these subjects

The last chapter, which concerns the radiation therapy of intracranial tumors, is mainly a review of the significant literature pertaining to the subject The author believes that roentgentherapy without surgery may carry many dangers and advocates a combination of surgical and roentgentherapy even in the case of radiosensitive tumors

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J N Ané, MD	H W Hefke MD	E A Pohle, MD Ph D
L J Carter, MD	E T Leddy, MD	C G Sutherland, MD
J E Habbe, MD	H C Ochsner MD	

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dollars the new edifice was opened during Christmas week in 1925. There is an entrance on each street, and parking facilities are arranged at reasonable rates with an all-electric garage close by, assuring ten-minute maximum delivery, with no charge for pickup or delivery.

Having over 2,200 guest rooms, 60 stores and shops, 16 private dining rooms, including two great ballrooms and five large public dining rooms under its roof, the Palmer House leads the way for modern hotel service. An average of over 8,000 persons daily are served in its dining room. Monsieur Ernest E. Amiet, the world's highest paid chef, is in charge of the nine Palmer House kitchens.

On the fourth floor of the hotel is the famous Palmer House exhibition hall, containing over 20,000 square feet of floor space adapted to the staging of convention displays and commercial exhibits. Directly over this space is the Club floor where an entirely private convention unit is at the service of meetings registering one hundred or more persons. This contains private meeting rooms, private checking and rest rooms, a large meeting hall and a private dining room.

There is a playground on the twenty-fifth floor for the convenience of persons traveling with their children. There is an outdoor fenced court where children may play in the sun and fresh air. A trained nurse is on constant duty, and meals are served there.

All in all the Palmer House is thoroughly equipped to meet any and every need of its many visitors and guests.

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## BOOK REVIEW

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INTRACRANIAL TUMORS ROENTGENOLOGICALLY  
CONSIDERED. LOYAL DAVIS, M.D., Ph.D.  
F.A.C.S. Professor of Surgery, Northwestern  
University Medical School. Attending

Surgeon to Passavant Memorial Michael Reese, and Wesley Memorial Hospitals, Consulting Neurological Surgeon to Edward Hines, Jr., Memorial Hospital, Chicago. Volume XIV of Annals of Roentgenology, a series of monographic atlases, edited by James T. Case, M.D., Professor of Roentgenology, Northwestern University Medical School, Chicago. A volume of 225 pages, 121 roentgenographic studies, 84 clinical illustrations, and 1 colored plate. Published by Paul B. Hoeber, Inc., New York City. Price, \$10.00.

For many years there has existed a need for a comprehensive text-book concerning the modern roentgenologic aspects of intracranial disease and this deficiency in the literature of a rapidly developing branch of medicine and surgery has undoubtedly prompted the author, who is a neurosurgeon, to write this monograph. No one will deny Dr. Davis' ability as a neurosurgeon, but his invasion of the domain of the roentgenologist can hardly be called a success. The author has failed to grasp the roentgenologist's needs and viewpoint to such an extent that the text concerning the roentgenologic features seems quite inadequate and is a poor example of what roentgenology can offer in this important field.

The pathology and significant clinical data concerning the various types of brain tumors are discussed in an excellent manner and much of the literature pertinent to the subject is reviewed. The novice will wish that the roentgenologic changes and differential diagnosis had been discussed in greater detail while the experienced roentgenologist will note the omission of many significant diagnostic changes and differ with some of the statements presented. For example in discussing the changes in the sella resulting secondary to hydrocephalus incident to posterior fossa tumor the author states that "the floor of the sella becomes thin but does not bulge downward and its continuity is not destroyed, etc." This of course is not true since the floor of the pituitary fossa is frequently completely destroyed and the pituitary gland pushed into the sphenoidal sinus by the increase of intracranial pressure as roentgenologists familiar

course varies considerably in severity, sometimes resulting in permanent disability. Some writers believe there is no need for operative intervention, as the condition has a tendency to recur. In the case reported the bony formation did recur after operation, but after four months the patient was symptom-free and active in spite of the recurrence.

C G SUTHERLAND, M D

## BONE DISEASES (DIAGNOSIS)

Lunate Osteomalacia, or Kienböck's Disease. W S Butler. *Can Med Assn Jour*, June, 1932, XXVI, 710, 711

Lunate osteomalacia is a peculiar lesion of the lunate, or semilunar, bone of the wrist, resulting in necrosis. Kienböck, in 1910, first described its x-ray appearance.

The author presents a case report of a white male, aged 53, with pain in the left wrist, on movement. Soon after the onset, one year before there had been swelling on the dorsum of the left wrist, and limitation of flexion and extension. There was no history of injury. The x-ray showed malformation, rarefaction and an ill defined margin of the bone, with some shrinkage.

The main points concerning this disease are the undetermined cause, the major degree of disability, the fact that surgical removal of the bone does not remove the disability, which is a rarefying osteitis.

L J CARTER, M D

Osteitis Deformans (Paget). Bachmann. *Röntgenpraxis* March, 1933, V, 161-170

The author is of the opinion that the osteitis deformans (Paget) and the osteitis fibrosa (Recklinghausen) are two definitely separated disease entities. The osteitis deformans is not rarely found roentgenologically without clinical symptoms. The characteristic roentgen symptoms with changes in pelvis and spine are described in four cases. Architectural changes of the trabeculae which are thickened, small irregular areas of decreased density between them but no bone atrophy, bowing of the bones with widening of the extremities and a changed architecture of the bone or widening by periosteal and sclerotic deposits (suggest Paget's disease) changes seen in other parts of the skeleton on roentgenologic examination. The generally accepted teaching of the occurrence of pathologic fractures in Paget's disease appears doubtful to the author. In his cases no pathologic fracture could be demonstrated, neither was any found in the institute of Schmorl. Only in one case with large cystic changes and a soft tissue tumor (malignant degeneration) was there a spontaneous fracture. In another case the differential diagnosis between osteitis fibrosa, osteoplastic enchondromatosis and Paget's disease is discussed.

H W HILKE, M D

An Unusual Disease of the Bone Marrow (Osteomyelodysplasia). Clifford G Grulee, Carl W Apfelbach, and Ralph E McMaster. *Jour Am Med Assn*, Jan 21, 1933, C, 162-167

These authors report a peculiar case of bone marrow change found in a 7-year-old boy. There was a high and irregular fever for several months. The general condition was at all times indefinite except for marked leukopenia and definite thinning of the cortex of the bones, which grew progressively more marked. Undulant fever was effectually ruled out by all tests that were tried. Neither in the roentgenograms nor at autopsy were myelomatous masses discovered such as are characteristic of myeloma.

While it was conceivable that the temperature curve might be attributed to agranulocytosis, certainly the bone changes had nothing to do with this disease. Leukemia was definitely excluded. The pathologic changes indicated that the hyperplasia of the bone marrow resulted from an inadequate escape of blood from the marrow, resulting in stasis followed by bleeding and necrosis. The atrophy of bone resulted from the increase of marrow because in the regions in which there was hyperplasia of bone marrow the growing red cells and white cells were in contact with the surface of the bone.

C G SUTHERLAND, M D

## BONE DISEASES (THERAPY)

Surgical Stimulation of Bone Growth by a New Procedure. Preliminary Report. Albert B Ferguson. *Jour Am Med Assn*, Jan 7, 1933, C, 26

Study of the factors influencing bone growth suggested that interruption of the medullary blood supply of the tibia had stimulated growth. Most processes that increase the growth rate at the epiphyseal disks result in premature union of the disks so that the final result may actually be shortening. Correction of examples in cases of fracture, osteotomy, prenatal fracture, bone cyst, abscess, and amputation led to the conclusion that interruption of the medullary blood supply to a metaphysis resulted in about 30 per cent increase of longitudinal growth rate at the metaphysis. An obvious suggestion from the phenomenon stated is that growth of tubular bones can be stimulated to grow about one eighth inch for each epiphysis annually during the growing period by the simple process of drilling into the bone halfway from the epiphyseal line or lines to the middle of the bone, inserting a knife or curet and disrupting the continuity of the medullary substance.

Up to October 1932 such an operation has been done in 16 cases in which there was a short leg. Seven bones operated on in four cases were examined from three to five months after operation. In each bone roentgenograms showed a gain in length of from one sixteenth to one-eighth inch on the corresponding bone on the opposite leg. It is

## APPARATUS

The Replacement of Roentgen Films by Roentgen Paper A Adam and K. Greineder Röntgenpraxis, February, 1933, V, 121-129

On the basis of considerable experience in internal and surgical roentgenologic diagnosis in the Roentgen Institute (Prof. Chaoul) of the Surgical Clinic of the Charité in Berlin the authors came to the following conclusions

1 Difference in sensitivity between film and paper a more level gradation curve, and other factors are not of sufficient importance to lessen its practical use

2 A decrease in the efficiency of roentgenologic diagnosis and too large increase of efforts and time is not to be feared in instances in which the paper has replaced the film

3 A certain limitation in the use of the paper is to be admitted for exposures which are by themselves technically difficult. These occurrences are relatively rare and due only to not yet efficiently developed paper technique.

4 The use of Chaoul's simultaneous exposure of two paper films in chest work is recommended

5 Roentgen paper offers undoubted economic advantages, as it lowers the cost of the roentgen laboratory directly

6 The paper is good enough to take the place of films entirely

7 Critical considerations are yet necessary. The authors see in the paper a technical progress similar to the introduction of the film instead of the glass plate

H. W. HEFKE, M.D.

An Improvement in Roentgenographic Technique. London letter quoting N. S. Finzi Jour Am Med Assn, Jan 7, 1933, C, 53

At the British Institute of Radiology is a new intensifying screen which allows much more rapid x-ray exposures. It is made from refined zinc sulphate and has been named 'fluorazure' on account of its intense azure blue fluorescence. The calcium tungstate screens in use have reduced the exposure time to about one-tenth but with fluorazure the period is reduced to a third or a fifth of that with tungstate. The details obtained with the fluorazure screen are just as good as with the best tungstate screen and 'graininess' which heretofore has prevented the adoption of zinc sulphide, is not apparent. For objects of unusual density such as the chest contrast is increased by the new screen. Good roentgenograms of the chest have been obtained at a distance of 6 feet with an exposure of 1/15 second; an exposure of 1/100 second is only a matter of obtaining a suitable switch. Direct cinematography of the chest may now be possible for x-ray work.

C. G. SUTHERLAND, M.D.

## ARTHRITIS

Recent Advances in X-ray Treatment of Asthma and Rheumatism S. Gilbert Scott Proc Roy Soc. Med, May, 1932, XXV, 972-974

The author briefly reviews the history of roentgen treatment of asthma, the beneficial effect of which he attributes solely to irradiation of the spleen. One large field is used for the abdomen and one for the back, x-rays of medium wave length being employed. The dose is so regulated that the tolerance dose is fully maintained for the whole series. Deep therapy must not be used.

In the treatment of rheumatism, the author has obtained best results by the use of x-rays of medium wave length (110 K.V., with aluminum filter). In the osteo arthritic group and infective conditions, he radiates individual joints. The rheumatoid arthritic group does not respond to this method. Spondylitis deformans in young individuals does if treated within two years of the onset, while acute arthritis rapidly shows favorable response.

H. C. OCHSNER, M.D.

## BONE (THERAPY)

Pellegrini-Stieda's Disease. A Report of One Case Surgically Treated. Jacob Kulowski Jour Am Med Assn April 1, 1933, C, 1014

Pellegrini-Stieda's disease is characterized by a semilunar-like bony formation in the region of the internal condyle of the femur and is always traumatic in origin. Pellegrini in 1905 called attention to a traumatic ossification of the collateral tibial ligament of the knee. Köhler in 1905, reported a similar case and in 1907, Stieda unaware of the previous work again called attention to a semilunar-shaped calcification seen about the superior border of the internal epicondyle of the femur. Pellegrini thought the disease was traumatic. Stieda believed it was due to a fracture, with a detachment of a small particle of bone at the moment of injury with subsequent calcification taking place in the ligament, while König, Köhler, Pfister and Fwald were definitely of the opinion that the calcification was a fractureless callus formation and that it was the result of periosteal proliferation secondary to a tear of the ligaments and tendons at that point. They support their contention with the fact that the process never appears within less than from two to three weeks following the injury. Most observers feel that it can be caused by either direct or indirect trauma.

There is still some controversy over the origin of the formation, some believing it to be of periosteal tissues. The author believes that it arises from the surrounding connective tissue and that the condition is similar to myositis ossificans.

More than 136 cases have been reported in Germany and Italy. It is chiefly unilateral. The clinical

Carcinoma of the Lip R. Stewart-Harrison  
*Strahlentherapie*, 1933, XLVI, 401

The author first discusses briefly the changes which the treatment of carcinoma of the lip has undergone during the past years. He then analyzes in detail 42 cases observed at the University Clinics in Zurich during the period 1919-1931. Operation and radiation therapy are compared. From the literature it appears that radiation therapy of carcinoma of the lip leads to a 3-year cure in from 70 to 80 per cent of the cases while operation cures not more than 60 per cent. In some statistics the latter figure is much smaller. He asserts that radiation therapy of the primary tumor is the method of choice. If there is no enlargement of the regional glands, it is justifiable to wait. In case of involvement, resection of the glands followed by roentgen therapy should be carried out. From a tabulation of the author's results it appears that 55.8 per cent of the patients are alive and have been free from symptoms over a period of from three to 13 years. A good bibliography is appended.

ERNST A. POHLE, M.D., Ph.D.

### THE CHEST (DIAGNOSIS)

Non obstructive Emphysema. W. B. Kountz and H. L. Alexander. *Our Am Med Assn*, Feb 25, 1933 C, 551

It has generally been believed that the underlying lesion of emphysema is primarily in the lungs. Two clinical types have long been recognized: one associated with bronchial obstruction, the other, the non-obstructive type (senile or arteriosclerotic) which has been attributed to degenerative changes in the pulmonary tissues. The respiratory function of the patient with non-obstructive or senile emphysema was compared with that of normal controls and patients with bronchial obstruction. The diaphragmatic excursion was greatly increased when compared to that of obstructive emphysema and greater than that of normal individuals. In non-obstructive emphysema the abdominal cavity was greatly increased whereas in the obstructive type the thoracic excursion was greater than in the normal. In experimental work the authors soon noted the uniform presence of straightness and stiffness of the thoracic spine in non-obstructive emphysema. The roentgenograms of obstructive emphysema show a continuous curve of the dorsal spine.

Kountz and Alexander found no experimental or definite clinical evidence to support the theory that emphysema with a fixed chest is due to over action of the inspiratory muscles over those of expiration. Muscle degeneration is a result of bony deformity and is a secondary phenomenon. That emphysema is due to ossification of the costal cartilages and to fixation of the costovertebral bodies could not be substantiated. The authors consider that non-obstructive emphysema is not primarily a pulmonary

disease but merely a change in the position of the lungs secondary to an increase in the size of the thoracic cage. In advanced cases, alveolar distention, with loss of elasticity, occurs. The thoracic deformity is due to a straightening of the dorsal spine, with kyphosis in the later stages. The underlying lesion is a degenerative process in the intervertebral discs.

C. G. SUTHERLAND, M.D.

Some Considerations of the Capillary Line in the Right Lung. Armando Zuppa. *Archivio di Radiologia*, 1933, XI, 146-155.

The author states that this line occurs in about 40 per cent of the cases he studied. It is a change due to interlobar inflammation and is best visualized by making the exposure at a distance of 15 meters with the patient prone.

E. T. LEDDY, M.D.

### THE CHEST (GENERAL)

Blastomycosis of the Gingiva and Jaw. A. Crich. *Can Med Assn Jour*, June 1932 XXVI 662-665.

Blastomycosis involving the gum tissue or jaw is extremely rare. The case herein reported is of interest not only on account of its rare location but also because of its infiltration of the left lung apex. Following removal of the lower left central incisor for an infected condition, there occurred a marked hyperplasia of the epithelial tissue in the area with an ulcer on the buccal surface. The submaxillary glands were swollen and hard. A roentgenogram of the affected area showed complete loss of bone in the region from which the tooth had been removed. Pathologic examination of a specimen revealed blastomycosis. X-ray examination of the lungs showed an extensive infiltration of the left apex which resembled pulmonary tuberculosis. Sputum was negative for tubercle bacilli. There was cloudiness of the right intrum, and a small amount of pus obtained on irrigation. Later a number of small red swellings resembling the tumors seen in erythema nodosum were noted on the legs.

The jaw lesion was destroyed with surgical diathermy and the glands of the neck irradiated.

I. I. CARTER, M.D.

### CONTRAST MEDIA

Death after Thorotrast Injections. Carl Livers. *Röntgenpraxis* March 1933 V, 207-208.

There is comparatively little published about the harmful effects of intravenous injections of thorotrast for the roentgenologic demonstration of liver and spleen. The several authors who have published their results at this new method do not believe that there is any immediate danger from its use but some of them are aware that late effects from the deposition of the substance cannot be as yet entirely



believed the operation can be repeated if the increased growth rate slackens after from two to four years. No case has shown any evidence of disturbance of the bone other than the change in the growth rate. These cases will be followed through adolescence to determine the actual gain in length over a period of years for the various bones at various ages, and to determine at what period after operation growth is most rapid and how soon the increased growth rate slackens.

C. G. SUTHERLAND, M.D.

## CANCER (THERAPY)

The Economic Crisis and Cancer of the Digestive Tract. Paris letter quoting Victor Pauchet. *Ann. Med. Assn.* Feb. 11, 1933, C 436.

Attention is called to an increase in cancer of the digestive tract coinciding with the economic crisis. Never before has the writer observed so many gastric cancers nor more extensive or grave cases than during recent months. He assumes that the financial crisis has compelled many aged persons to neglect to consult their physicians promptly in regard to symptoms unless the latter become alarming. Gastric cancer begins insidiously and only an early intervention can arrest its development. Such early intervention effects 30 per cent of definite recoveries, that is to say recoveries extending over several years.

C. G. SUTHERLAND, M.D.

Treatment of Carcinoma of the Breast by Radium Emanation. H. S. Souttar. *British Med. Jour.* Mar. 13, 1933, No. 3775, p. 813-815.

The author discusses the results obtained in the treatment of 52 cases of carcinoma of the breast by radon seeds and is of the opinion that this form of therapy is applicable to almost every case of this condition. He believes that there is no case so advanced that local relief is impossible, while in the earliest cases he is convinced that the surgeon is fully justified in offering this alternative to amputation. However in the early cases careful, thorough and frequent observations should be the rule and in the event of a recurrence a complete amputation should be immediately performed.

The author's technic consists of the implantation of radon seeds into the tissues of the breast in such a manner that the whole of the breast and its lymphatic drainage is exposed to uniform radiation sufficient to destroy any carcinoma cells whether in the tumor, the breast or the lymphatics. A special introducer consisting essentially of a long hollow handle and a rotating barrel which holds the seeds is employed. About 100 seeds may be introduced each containing 0.5 to 1 millicurie the

amount varying with the dimensions of the breast and the tumor. The seeds are introduced in such a manner that a grid is formed beneath the tumor, and actually in the primary area of its lymphatic drainage. No seeds should be inserted in the more superficial portions of the tumor as these will only destroy the skin. Two rows of seeds are introduced beneath the pectoralis major below the axillary vessels, and two additional rows along the axillary border of the pectoralis major. In this manner an effort should be made to perform a complete Halstead by means of irradiation.

A few days after the introduction of the seeds it was noted that the tumor became softer, and at the end of a week lost the induration characteristic of carcinoma. Small tumors should disappear in six weeks and the surface of fungating masses should heal in three months. Secondary glands and recurrences should disappear with greater ease than the original tumor, and in the majority of cases all traces of active carcinoma will have disappeared in three months.

The author's series of early cases consisted of 12 patients. Four died from generalization over an average period of three and a half years and eight remained alive and well after an average period of two and a half years. Of the 29 advanced but operable cases, seven died from generalization after an average of 18 months, two died from other causes and 20 were alive and well at periods up to four years. Of the 11 inoperable cases only one remained alive and well after three years.

J. A. AVE, M.D.

Preliminary Experience in Cancer Therapy with Extremely Hard Roentgen Rays. E. v. Schubert. *Strahlentherapie* 1932, XLIV, 293-310.

The author relates in this article his experience with roentgen rays produced at 500 K.V. in the treatment of pelvic malignancies. Roentgen tubes can be operated in clinics up to 600 K.V. without danger and without more difficulties than are encountered in present deep therapy in trillations. The effects of these extremely hard roentgen rays on body tissues and blood are relatively small with proper dosage in intense carcinoma therapy is possible. It is advisable not to exceed the tolerance of the skin and surrounding tissue. A radio epidermitis can be avoided if slightly less than 200 r are given every other day and not more than 14 single sittings over the same area during 28 days. Whether the good response of the carcinoma is due to the extremely short wave length or to the fractional protracted dose method cannot be decided at the present time. The author is continuing his experiments which may lead to the use of roentgen rays produced at 900 kilovolts.

ERNEST A. POHLE, M.D., Ph.D.

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denied Urticaria, severe skin and mucosa hemorrhages, chills with headaches, diarrhea, and attacks of asthma have been reported as immediate after-effects of thorotrast. One death due to the injection has been described, there was collapse and a necrosis of the spleen caused by a thrombosis of the splenic vein. The author's patient was a 71-year-old woman in whom a tentative clinical diagnosis of carcinoma of the liver had been made. After the third thorotrast injection the patient became sleepy, the pulse became fast, and albumin was found in the urine. Twenty-four hours after the injection death took place. Postmortem examination showed a high degree of fatty degeneration of the liver.

H. W. HEFKE, M.D.

Hepatohepatography with Thorotrast. D. Vrijano. *Archivio di Radiologia*, 1933, XI, 57-145.

After a review of the literature covering the experimental and clinical aspects of the use of thorotrast, the author reports extensive experiments he performed on rabbits and dogs to determine the uses of the compound, as well as the dangers following its administration. He found that intravenous injections of thorotrast in doses six times that necessary to produce visualization of the spleen or liver are harmless, but where doses higher than that are used, for example to visualize the placenta, the bone marrow, the lungs or kidneys, toxic effects may appear. According to his experiments, thorotrast is eliminated principally by the intestine through the bile and to a less extent by the kidneys.

E. T. LEDDY, M.D.

## DENTAL RADIOGRAPHY

Roentgenographically Negative Pulpless Teeth as Foci of Infection. Editorial. *Jour Am Med Assn*, March 25, 1933, C, 974.

The teeth are studied as foci of infection and the surprising lack of agreement as to which teeth are to be so considered is remarked upon. From the experimental point of view Haden considered pulpless roentgenographically negative teeth almost as potent in causing systemic disease as those having frank destruction at the roots. Recently, Rhoads

and Dick made a study to throw additional light on the pathologic significance of pulpless roentgenographically negative teeth. The average bacterial count of the 29 pulpless roentgenographically negative teeth was 759,574, while the average count of controls was 1,876. Cultures of the pulpless teeth yielded green-forming streptococci in every instance. In view of the results of quantitative cultures by Haden and by Rhoads and Dick, it seems justifiable to regard all pulpless teeth as possible foci of infection, whether they show apical changes in the roentgenograms or not. At least, this position should be taken in the presence of systemic disease of a type usually associated with focal infection.

C. G. SUTHERLAND, M.D.

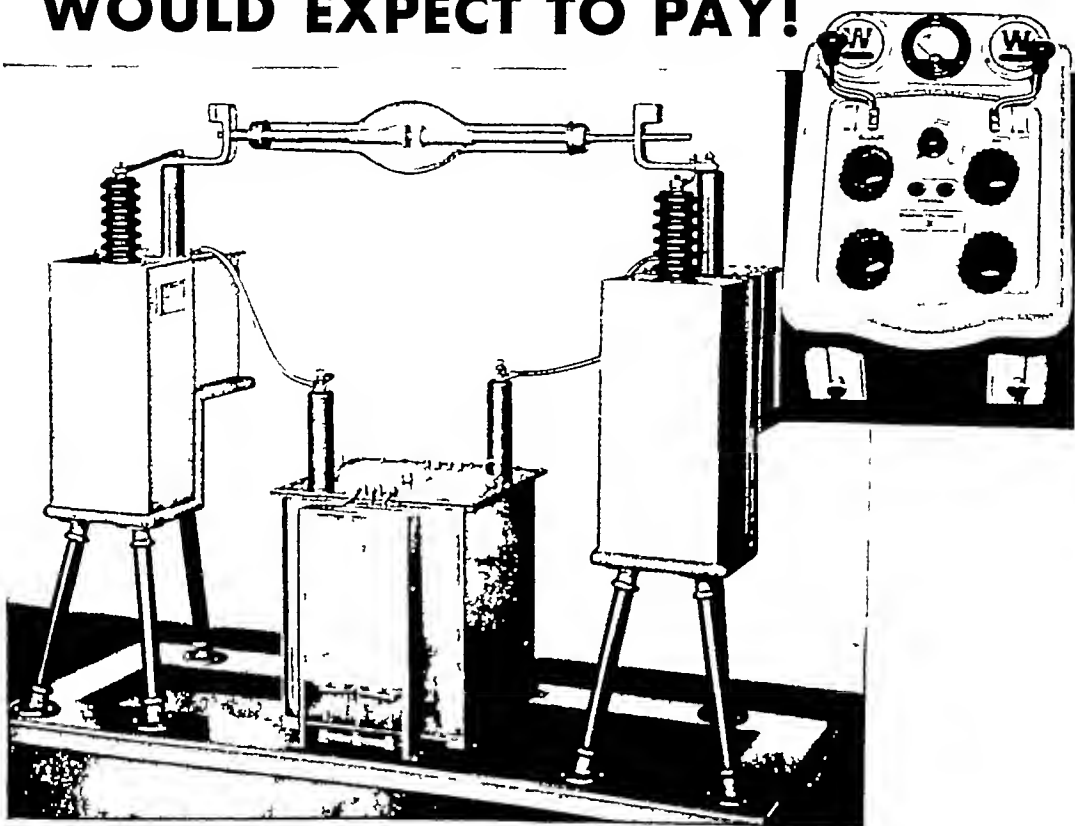
## DOSAGE

Water Phantom Intensity Measurements of Roentgen Rays Produced by 127,000 Volts. J. L. Weatherwax and Charles Robb. *Am Jour Roentgenol and Rad Ther*, May, 1932, XXVII, 749-754.

It has not yet been proven conclusively that different x-ray wave lengths have a selective action on malignant tissue, hence, the writers have felt the wisdom of working out isodose charts using radiation produced by 127,000 volts, which can be applied where such voltage is used in conjunction with 200,000-volt therapy or alone. An ionization chamber of the Friedrich-Krönig type attached to an electroscopic system was used, the chamber being placed in the center of the field of radiation half submerged in water and at various depths below the surface. Ionization curves showing the relative intensity in water produced by 127,000 volts, 40 cm target skin distance filters of 4 mm Al and 6 mm Al for fields 20 cm in diameter, 16 × 16 cm and 14 × 14 cm were plotted. The erythema dose is considered to be 600 r for 4 mm Al and 650 r for 6 mm Al. It is pointed out that when cross firing over the tumor is done, the skin and intervening tissues between the surface and the tumor will be less damaged by treating all the fields at each treatment period giving a small dose to each area. This method is in this respect preferable to that of giving the entire dose through one portal on each treatment day.

J. E. HANNE, M.D.

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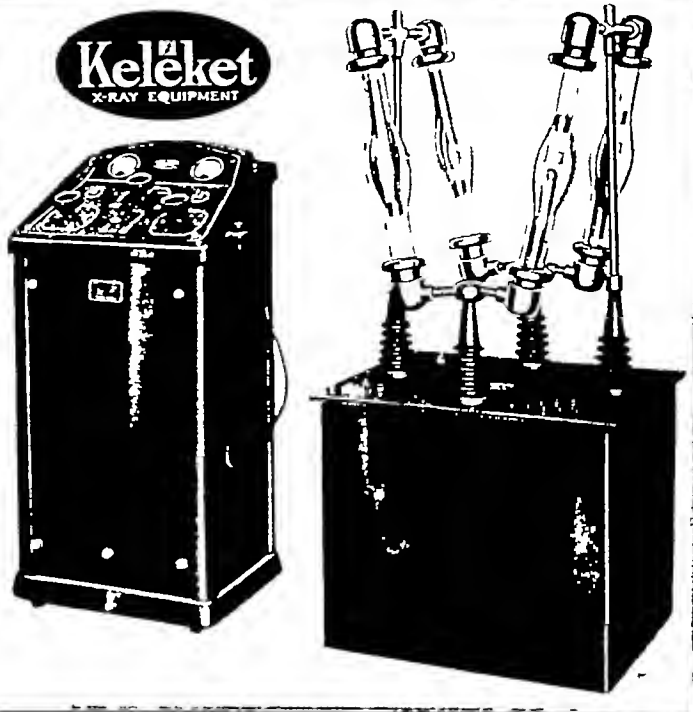
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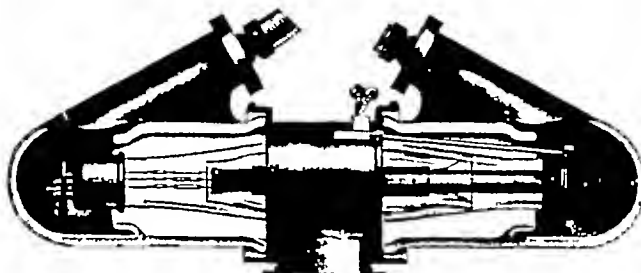
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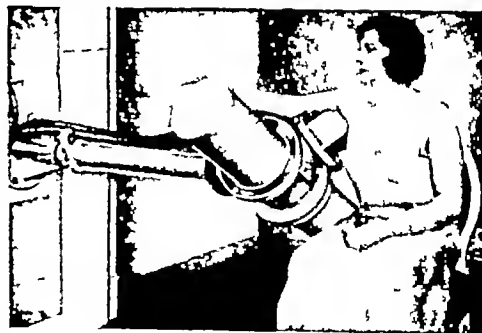
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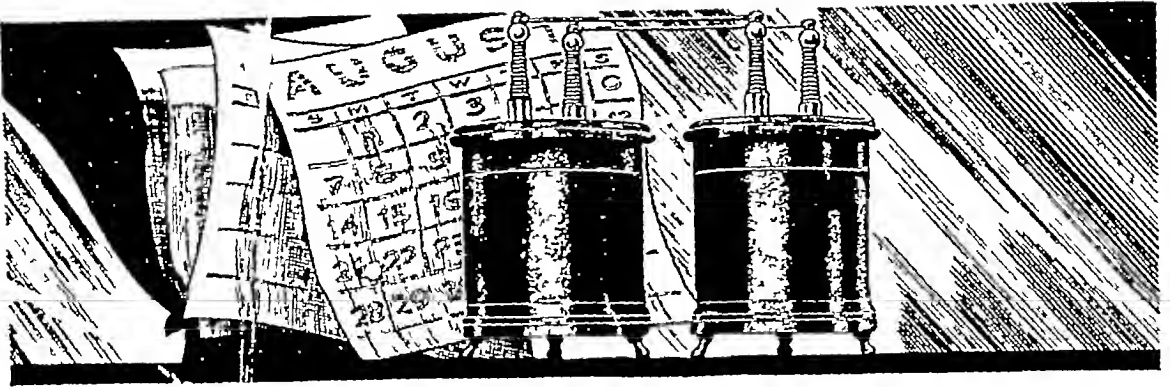
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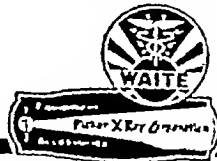
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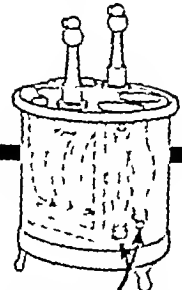
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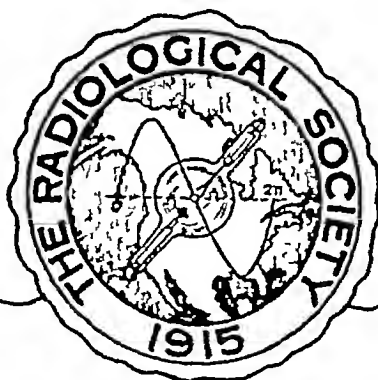
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SEPTEMBER, 1933

Volume XXI

Number 3

Sept. 25-30, 1933, Chicago, American Congress of Radiology Joint Meeting of all  
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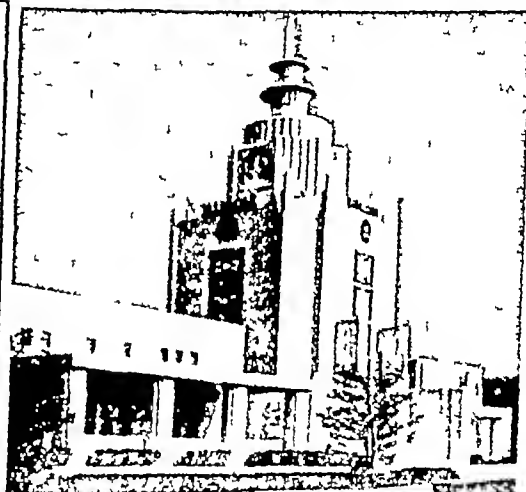
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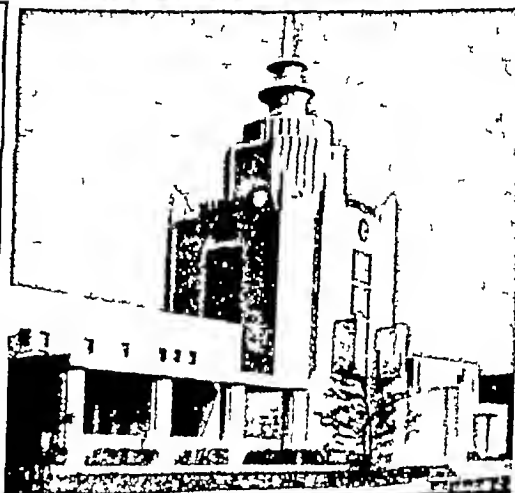
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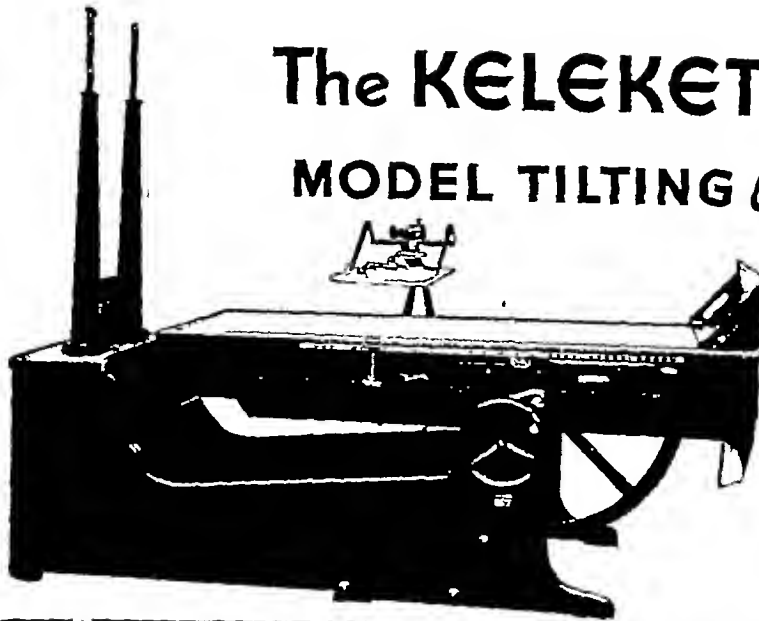
A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. XVI

SEPTEMBER, 1933

No. 3

## PULMONARY EMPHYSEMA ASSOCIATED WITH ARRESTED PULMONARY TUBERCULOSIS<sup>1</sup>

By KENNON DUNHAM M.D. CINCINNATI

THE purpose of my paper is to demonstrate how the x-rays can help in the diagnosis of emphysema, and to emphasize the importance of this study. I shall limit myself to emphysema in arrested tuberculosis, but I urge radiologists to help their clinical colleagues, as well as their patients by trying to include or exclude emphysema whenever chest plates are read.

Emphysema which is a constant sequela of arrested tuberculosis is frequently associated with sinus infection and is a serious complication in most chronic lung lesions. This serious complication is frequently overlooked to-day. Severe cases of psychoneurosis, with attacks of bronchial asthma, generally have emphysema as a base.

Our text-books describe the barrel-shaped chest and cyanosis as the outstanding findings in emphysema. Cyanosis occurs either during acute attacks associated with asthma or it is in end-result. The barrel-shaped chest is a late finding in tuberculous cases with emphysema.

Before 1890 clinicians paid great attention to this condition but little has been added to the literature since 1900. The best references for a complete study of emphysema are in "Diseases of the Lung and

Pleura," by Wilson Fox,<sup>2</sup> which was dedicated to Sir William Jenner. It is a joy to find that Jenner's article on emphysema, in Reynolds' System of Medicine, Volume I published in 1871, is a classic. I have seen nothing which Jenner has not described. I am only trying to help detect upon the films in life what he found at autopsy.

The x-ray diagnosis of emphysema is greatly aided by the pathology. If you have dilated air cells and thickening of pulmonary arteries, you have a pathology which increases the contrast of thoracic density. The trunks are widely separated and on good stereoscopic films it is easy to make out the trachea, the right and left bronchus, the pulmonary arteries, and the trunks leading to the various lobes of the lungs.

It is not unusual for emphysema to be more marked in one lung than in the other, it is most striking to see emphysema more marked in an upper lobe than in another lobe of the same lung. This phenomenon can be detected easily by the greater separation of the trunks in the particular lobe involved. But let me repeat that good stereoscopic plates are a necessity and the radiologist must be familiar with the thoracic anatomy. If he is not able to locate the lobes by following the various trunks on

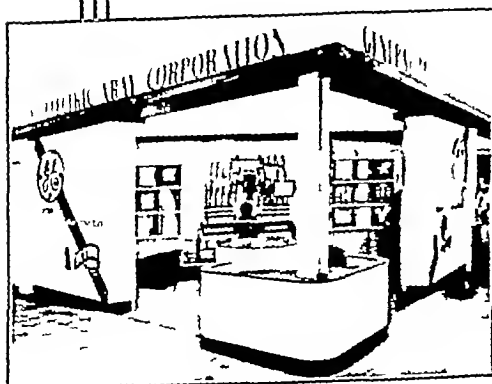
<sup>1</sup>Read before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City, Nov. 25, 1933.

<sup>2</sup>Fox, Wilson. Textbook of Thoracic Medicine, London, 1921.

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<sup>1</sup>Read before the Radiological Society of North America at the Thirtieth Annual Meeting at Atlantic City, Nov. 28-Dec. 1, 1932.

<sup>2</sup>Fox, Wilson. J. and A. Churchill, London, 1891.

good stereoscopic plates, he should not attempt to diagnose pulmonary emphysema.

When emphysema is severe, blebs are most often seen in the bases. These lesions have been well discussed by William Snow



Fig 1 Case 1 (1) Ribs wide and horizontal to spine, (2) right pulmonary artery dislocated up, (3) main stem bronchus inside pulmonary artery, (4) heart not seen to right of spine, (5) diaphragm low and flattened, (6) old fibroid lesions in upper right, (7) marked emphysema, upper left, trunks in all lobes widely separated

Miller,<sup>3</sup> after a study of a lung which I sent him, because I had made the diagnosis of emphysema from it during life. These large emphysematous areas which are quite common, are sometimes mistaken for cavities. It was difficult for the radiologist to teach the clinician that bronchiectasis existed long before the three-layer sputum was found. It is going to be even more difficult to teach that there are many degrees of emphysema. We use the terms mild, moderate, and severe, but there is no sharp dividing line. More study is required. A better understanding of emphysema is of great clinical value.

*Roentgenographic Technique*—Accurate stereoscopic films with good penetration, a lateral plate exactly exposed at right-angles

to the anteroposterior diameter of the chest, and a carefully made fluoroscopic examination are necessary. To this I have added plates taken after the injection of iodized oil, because these will prove your other findings.

Let me repeat. Any study of chest plates requires ability to interpret accurately the anatomy shown on the plates. Many times penetration rather than contrast is all-important to bring out the anatomy. Contrast is doubled by the two plates. Further, the plates must stereoscope accurately.

*Anatomy*—No two chests are alike and it takes much study to master the variations found in healthy chests. The bones, the trachea, the aorta, and the pulmonary arteries must be defined and their locations noted. The trunks leading to the upper lobes must be carefully studied. The middle lobe trunk, from the main stem bronchus on the right, and the lingual tip, from the bronchus of the upper left lobe, are very important, the bronchi to the upper third of each lower lobe, as they come off the right and left main stem bronchus must also be located. When these landmarks are found, you have defined the lobation and you are in a position to say whether or not there has been dislocation of the lobes and if the trunks to these various lobes are more or less widely separated than they should be. As I have said before, emphysema aids such a study.

*Ribs*—The ribs are well separated. The angles of their lower borders with the spine are always more obtuse than in health, often being right-angles. The upper border may show the more acute angle of the two, as has been brought out by Pincoast and others. The barrel-shaped chest is a late finding and is not best detected by films; the fluoroscope shows it better, but simple inspection is best. Palpation easily discloses that the ribs move up and down rather than expand. The costal cartilages are more or less calcified. This has been

<sup>3</sup>Miller, W. S. *Am Jour Roentgenol and Rad Ther*  
May 1926, Vol. 109, 407



Fig 2 Case 1 Iodized oil Cf with Figure 1



Fig 3 Lateral exposure

given as a cause of emphysema by Freund.<sup>4</sup> I believe that calcification of rib cartilage suggests only premature old age.

The *spine* is often bowed backward and the patient frequently has a bowed head, but, again, this is found only in long-standing cases.

*Anterior and Posterior Dark Areas*—Others have shown frequently, on lateral exposures that the anterior dark area extends down in front of the heart density, separating it from the sternum. This is true except in cases in which the pericardium is attached to the anterior chest wall. In such a case the posterior dark area is usually large. These points are well seen by the fluoroscope but the films make the record.

*Diaphragm*—The diaphragm is always low and is restricted in its movements, a fact which is best detected by the fluoroscope. It must be remembered that the diaphragm in healthy individuals moves up and down much more than one would expect. It is easy to believe that the diaphragm is moving normally when it really is greatly restricted. Further the principle

of the orthodiagraph should be used, because movement is easily magnified by improper fluoroscopic examination.

*Dislocation of Thoracic Viscera*—It has been striking to note to what extent the thoracic viscera may be dislocated by pleurisy and the contractile scar tissue of tuberculosis. The good lung expands to fill the thoracic cavity, the anatomic landmarks previously described are moved and the trunk markings are abnormally separated. In this way we have our most characteristic x-ray presentation of pulmonary emphysema. I have seen the left pulmonary artery dislocated almost to the top of the aorta.

Emphysematous blebs are a late manifestation and indicate severe emphysema. Asthma cyanosis and the barrel-shaped chest are frequently not present. Blebs, which are seen best at the inferior margins, may occur in an upper lobe or the upper third of a lower lobe, in which case they suggest cavity.

*Injection of Iodized Oil*—For several years I have noted that in certain cases injected with iodized oil the oil did not fill the air cells and therefore did not present

<sup>4</sup> Freund (Wurzb. Verhandl. 1859, 1861) thought that the first cause was an elevation of the cartilage of the upper ribs, by which they were forced upward and outward and the sternum forced up and upward. It is now generally believed that it is Jenner that Freund mistook the effect for the cause.



Fig 4 Case 2 (1) Old fibroid lesions with emphysema, (2) ribs wide apart and at right-angles to spine, (3) clavicles, right lower than left, (4) aorta suggests arteriosclerosis, (5) heart not seen to right of spine (6) diaphragm very low (7) blebs at right base, (8) marked emphysema below fibroid lesion in right upper, (9) marked emphysema below fibroid lesion in left base, (10) probable blebs above left diaphragm

the picture of a bronchopneumonia. Instead, the oil left a beautiful picture of the bronchial tubes. At first, I thought this was due to the quantity of oil used, and then I thought it might be due to the uneven temperature of the oil injected. Neither of these was correct, and it finally dawned upon me that these cases of uninjected air cells were all cases of emphysema. Such cases were sometimes associated with asthma and bronchitis, sometimes with bronchiectasis, and at other times with tuberculosis. The important point is that the air cells do not fill with the oil and we have never had an emphysematous bleb that filled. This is similar to a cavity—cavities seldom fill with the oil. When Bloch published his article on viscosity I determined to compare a very cold ( $18^{\circ}\text{C}$ ) and a warm injection ( $38^{\circ}\text{C}$ ). There is no difference on the films.

The importance of the study of emphysema cannot be over-estimated. Many pa-



Fig 5 Case 2 Iodized oil (1) Left bronchus dislocated upward (2) main stem bronchus dislocated upward and outward, (3) trunks to left lower lobe dislocated upward, (4) blebs at left base, (5) trunks on right widely separated, emphysematous blebs do not fill no density in the lungs resembling caseous bronchopneumonia

tients are unable to carry on even after their tuberculous lesions have become fully arrested. Many patients are returned to the sanatorium after discharge because they have severe cough and expectoration and the chest is full of rales. At times, such patients are so sick that they cannot recline but must be propped up in bed. An X-ray plate shows no new pulmonary lesions since the last examination. The clinician believes that there has been an extension of a tuberculous lesion which the X-ray does not show. After a few weeks in bed the patient rests easily, the cough subsides and the rales cannot be heard.

Such were the cases which first attracted my attention many years ago. A more careful study of the subject reveals that some degree of emphysema is associated with every case of arrested tuberculosis. When such a case is returned to his home the physician has not fulfilled his duty unless he has carefully observed the exercise of that patient to determine how many hours he should be up without rest in bed. Few cases of arrested tuberculosis should be up more than twelve hours. Some cannot be



Fig 6 Case 3 Ribs very wide throughout (1) Ribs contracted over left upper, (2) trachea drawn to the left (3) heart not seen to right of spine, (4) diaphragm very flat especially left dome, (5) old fibroid lesions both uppers but most marked on left, (6) aorta drawn to the left (7) emphysematous blebs at left base, less evident on right



Fig 7 Case 3 Iodized oil ( $38^{\circ}\text{C}$ ) (1) Trunks dropped stereoscopic films show them to be widely separated in antero-posterior diameter Slightly more mottling of viscous broncho-pneumonia than in Figure 6

up safely more than three hours followed by at least two in bed. The hours up must be prescribed for each individual case of arrested tuberculosis since each presents a different problem. While the heart, kidneys and other organs play a part emphy-



Fig 8. Case 3 Iodized oil ( $18^{\circ}\text{C}$ ) Injection of the lower part of the upper right lobe due to position and not to cold oil, mottling is about the same blebs are seen at both bases, very little difference between the hot and cold oil

sema is the greatest and most common handicap

It is to be remembered that such patients can do much more in the warm months than in the cold months. Infections (colds) in the upper or lower air passages greatly reduce the lung capacity, and this should be given serious consideration.

Less severe cases of emphysema associated with arrested tuberculosis present many symptoms. Erroneous diagnoses have been given, such as tuberculosis reactivated, psychoneurosis, nervous exhaustion, heart lesions of many varieties, chronic bronchitis, bronchiectasis. I have not tabulated all of them and cannot now remember the whole list.

The important point is when you examine a patient who is an arrested case of tuberculosis—no matter how long arrested, no matter how slight the lesion—consider and determine the extent to which pulmonary emphysema is causing the trouble. The x-rays are of great value in determining this. Remember that rest is the only treatment and the later you make the diagnosis the more rest is required.



# RECOMMENDATIONS OF THE THIRD INTERNATIONAL CONGRESS OF RADIOLOGY RELATING TO PROTECTION FROM X-RAYS AND RADIUM

By LAURISTON S. TAYLOR, Bureau of Standards WASHINGTON, D. C.

*Abstract*—The 1928 x-ray and radium protection proposals,<sup>1</sup> as revised and adopted by the Third International Congress of Radiology, Paris 1931, are given in their final form

## I INTRODUCTION

At the Second International Congress of Radiology, at Stockholm, in 1928, preliminary recommendations on x-ray, radium, and high voltage protection were adopted. At the same time a committee was appointed, for the further consideration of these proposals, which was to meet and render a report to the Third International Congress of Radiology, at Paris, in 1931. This committee consisted of the following representatives of their respective countries:

G Grossman	Germany	
R Ledoux-Lebard	France	
R Sievert	Sweden	
I Solomon	France	
L S. Taylor	United States	
E. Pugno	Venice, Italy	
G. W. C. Kaye	Great Britain	} <i>Honorary</i> } <i>Secretaries</i>
F. Melville	Great Britain	

At its meeting during the 1931 congress, certain revisions were made in the 1928 proposals. These changes are incorporated in the complete recommendations given below. At the same time provision was made for the formation of a subcommittee to make extensive revision of the parts on radium protection before the 1934 congress.

The recommendations as given below were adopted by unanimous consent by the members of the Third International Congress of Radiology.

## II RECOMMENDATIONS AS ADOPTED

1 The dangers of over-exposure to x-rays and radium can be avoided by the pro-

vision of adequate protection and suitable working conditions. It is the duty of those in charge of x-ray and radium departments to insure such conditions for their personnel. The known effects to be guarded against are:

- (a) Injuries to the superficial tissues
- (b) Derangements of internal organs and changes in the blood

1 *Working Hours, etc*—2 The following working hours, etc., are recommended for whole-time x-ray and radium workers:

- (a) Not more than seven working hours a day
- (b) Not more than five working days a week. The off-days to be spent as much as possible out of doors
- (c) Not less than 4 weeks' holiday (vacation) a year, preferably consecutively
- (d) Whole-time workers in hospital x-ray and radium departments should not be called upon for other hospital service
- (e) X-ray workers and particularly radium workers should be systematically submitted both on entry and subsequently at least twice a year to expert medical general and blood examinations. These examinations will determine the acceptance, refusal, limitation or termination of such occupation.

## 2 General X-ray Recommendations—

3 X-ray departments should not be situated below ground floor level

4 All rooms including dark rooms

<sup>1</sup>U. S. Circular No. 374, 1927

should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible

5 All rooms should be provided with adequate exhaust ventilation capable of renewing the air of the room not less than ten times an hour. Air inlets and outlets should be arranged to afford crosswise ventilation of the room.

6 All rooms should preferably be decorated in light colors.

7 A working temperature of about 18° C (65° F) is desirable in x-ray rooms.

8 X-ray rooms should be large enough to permit a convenient lay-out of the equipment. A minimum floor area of 250 square feet (25 square meters) is recommended for x-ray rooms and 100 square feet (10 square meters) for dark rooms. Ceilings should be not less than 11 feet (3.5 meters) high.

9 Wherever practicable the x-ray generating apparatus should be placed in a separate room from the x-ray tube.

### 3 X-ray Protective Recommendations

10 An x-ray operator should on no account expose himself unnecessarily to a direct beam of x-rays.

11 An operator should place himself as remote as practicable from the x-ray tube.

12 The x-ray tube should be surrounded as completely as possible with protective material of adequate lead equivalent.

13 The following lead equivalents are recommended under average conditions.

X-rays Generated by Peak Voltages Not Exceeding	Minimum Equivalent Thickness of Lead
(KV)	(mm)
75	1
100	1.5
125	2
150	2.5
175	3
200	4
250	6
300	9
350	12
400	15

14 In the case of diagnostic work, the operator should be afforded protection from scattered rays by a screen of a lead equivalent not less than 1 millimeter.

15 In the case of x-ray treatment the operator is best stationed completely outside the x-ray room behind a protective wall of a lead equivalent not less than 2 millimeters. This figure should be correspondingly increased if the protective value of the x-ray tube enclosure falls short of the values given in Paragraph 13. In such event the remaining walls, floor, and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances.

16 Screening examinations should be conducted as rapidly as possible, with minimum intensities and apertures. Palpation with the hand should be reduced to the minimum.

17 The lead glass of fluorescent screens should have the protective values recommended in Paragraph 13.

18 In the case of screening stands the fluorescent screen should, if necessary, be provided with a protective "surround" so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm.

19 Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient.

20 Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall.

21 Efficient safeguards should be adopted to avoid the omission of a metal filter in x-ray treatment.

22 Protective gloves, which should be suitably lined with fabric or other material should have a protective value not less than  $\frac{1}{32}$  mm lead throughout both back and front (including fingers and wrist). Protective

aprons should have a minimum lead value of  $\frac{1}{2}$  millimeter

4 *Electrical Precautions in X-ray Rooms*—23 The floor covering of the x-ray room should be of insulating material such as wood, rubber, or linoleum

24 The overhead conductors should be not less than 9 feet (3 meters) from the floor. They should consist of stout metal tubing or other coronaless type of conductor. The associated connecting leads should be of coronaless wire kept taut by suitable rheophores

25 Wherever possible earthed guards or earthed sheaths should be provided to shield the more adjacent parts of the high tension system. The use of x-ray equipment having the high tension circuit completely enclosed in earthed conductors is specially recommended. Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed

26 The use of quick-acting double-pole circuit breakers is recommended. Overpowered fuses should not be used. If more than one apparatus is operated from a common generator, suitable overhead multi-way switches should be provided

27 Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the x-ray tube

28 Special electrical precautions should be taken in rooms where anesthetics are used in conjunction with x-rays

5 *Film-storage Precautions*—29 The use of non-flammable x-ray films should be encouraged. In the case of flammable films suitable precautions should be taken as regards their use and storage. Large stocks should be kept in isolated stores preferably in a separate building or on the roof

6 *Radium Protective Recommendations* (1) *Radium Salts*—30 Protection for radium workers is required from

the effects of (a) beta rays upon the hands, and (b) gamma rays upon the internal organs vascular and reproductive systems

31 In order to protect the hands from beta rays reliance should be placed, in the first place, on distance. The radium should be manipulated with long-handled forceps and should be carried from place to place in long-handled boxes, lined on all sides with at least 1 cm of lead. All manipulations should be carried out as rapidly as possible

32 Radium when not in use should be stored in a safe as distant as possible from the personnel. It is recommended that radium tubes or applicators be inserted into separate lead blocks in the safe, giving a thickness of protective wall amounting to the values given in the following table

Maximum Quantity of Radium Element	Thickness of Lead
(gm)	(cm)
2	8.5
5	10
10	11.5
20	13
50	15
100	17

33 A separate room should be provided for the "make-up" of screened tubes and applicators, and this room should be occupied only during such work

34 In order to protect the body from the penetrating gamma rays during handling of the radium a screen of not less than 2.5 cm of lead should be used and proximity to the radium should occur only during actual work for as short a time as possible

35 The measurement room should be a separate room and it should preferably contain the radium only during its actual measurement

36 Nurses and attendants should not remain in the same room as patients undergoing radium treatment with quantities exceeding one-half gram

37 All unskilled work or work which

can be learned in a short period of time should preferably be carried out by temporary workers, who should be engaged on such work for periods not exceeding six months. This applies especially to nurses and those engaged in "making-up" applicators.

38 Discretion should be exercised in transmitting radium salts by post. In the case of small quantities it is recommended that the container should be lined throughout with lead not less than 3 mm thick. It is more satisfactory to transport large quantities by hand in a suitably designed carrying case.

(B) *Emanation*—39 In the manipulation of emanation, protection against the beta and gamma rays has likewise to be provided.

40 The handling of emanation should be carried out, as far as possible, during its relatively inactive state.

41 The escape of emanation should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan.

42 Where emanation is likely to come in direct contact with the fingers thin rubber gloves should be worn to avoid contamination of the hands with active deposit. Otherwise the protective measure recommended for radium salts should be carried out.

43 The pumping room should preferably be contained in a separate building. The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect persons working in adjacent rooms. This is preferably done by placing the radium in solution in a lead-lined box the thickness of lead recommended being according to the table in Paragraph 32.

equivalent" be used. Sheet lead is, however, the safest and most permanent protection, and should be used whenever possible.<sup>2</sup> If protective plasters are used, great care must be taken in their preparation and application in order to insure a uniform protective value. Papers by Hunt<sup>3, 4</sup> discuss the properties and use of such materials.

In most x-ray departments the lighting is inadequate and the ventilation poor. These are two factors which are very commonly overlooked in the design of x-ray departments and consequently particular attention should be given to Paragraphs 4 and 5.

There is frequently also a lack of sufficient auxiliary protective aprons on screening stands and couches, thus exposing the operator to the very soft radiation scattered from the patient's body. This is one of the most common sources of danger to the doctor.

Since the Second International Congress of Radiology in 1928, the Advisory Committee on X-ray and Radium Protection in the United States has drawn up a very complete set of x-ray and high tension protection recommendations.<sup>5</sup> It is believed that these recommendations contain all the information necessary to provide adequate protection under all conditions.

While with the advent of new self-protected x-ray tubes, and new apparatus, such as high tension cables and oil-immersed equipment, many of the problems in protection are simplified, the older type of equipment will undoubtedly be used for some time, and, therefore, proper attention should be given to all new installations as well as existing ones.

In order to continue the work in protection the Congress has retained the Protection Committee which will report an

### III DISCUSSION

The proposals do not specify the use of sheet lead but state that a certain "lead

<sup>1</sup> L. S. Taylor, X-ray Protection, *Am Jour Roentgenol and Rad Ther*, 1929, **XXII**, 45.

<sup>2</sup> L. Hunt and M. Temin, *RADIOLOGY*, February 1927, 1925, **XIV**, 524.

<sup>3</sup> L. Hunt, *Am Jour Roentgenol and Rad Ther*, 1931, **XXII**, 542.

<sup>4</sup> Bureau of Standards, *Handbook No. 15*, 1931, *RADIOLOGY*, 1931, **XXII**, 436.

<sup>5</sup> *Am Jour Roentgenol and Rad Ther*, 1931, **XXII**, 436.

further progress at the Fourth International Congress of Radiology, at Zurich, in 1934. In this country we have an Advisory Committee which will recommend any changes or additions arising from experience and advance in the United States. To this Committee should be referred any questions or

suggestions regarding x-ray protection and if no settlement can be reached, they will be taken up by the International Committee Communications pertaining to the code should be transmitted through the author who is the American representative on the International Committee.

## SHALL WE RECORD AND REPORT ALL X-RAY DOSAGE IN ROENTGENS?<sup>1</sup>

By R. R. NEWELL, M.D., SAN FRANCISCO  
Stanford University School of Medicine

**T**HIS is not a report of physical measurement, nor a record of clinical observations. What I have to present is a proposition for discussion.

It was three and a half years ago that we were given a precisely defined and internationally accepted unit of roentgen dosage. It is true that the realization of the official unit, the roentgen, and its distribution to clinical roentgen therapists have proved difficult. Clinical roentgenometers do not always agree perfectly with each other, which makes one feel uncertain as to the correctness and permanence of their calibration. One feels like sending his instrument to our U. S. Bureau of Standards for calibration. Another possibility appears in Rajewski's (1) radium standard for small ionization chambers so arranged as to be little susceptible to small errors in the geometrical arrangement of the test. With this one could carry the standardization (or, rather, the check on original calibration) to the instrument instead of sending the instrument to Washington. Taylor has told us that he carried a primary standard around Europe and found the national institutes in good agreement. With their service available to users of clinical roentgen-

ometers, I think practical roentgenometry is reaching a satisfactory state of dependability.

The cost of a good roentgenometer, with small chamber calibrated in r, is not too great for us to afford. Expensive ones may be had with an integrating arrangement to keep account of the total amount, but I cannot see the necessity for this as long as we have clocks.

Gamma radiation has always been outside the calibrated range of our ionometers, the factor for wave length being unknown for a small chamber of any construction. Farth and Henshaw (2) have recently given us a good evaluation of the r per minute intensity of a gamma-ray beam (36 r per minute per gram of radium element at 1 cm distance). It is interesting to note that a graphite chamber could be recalibrated for gamma rays and prove dependable, but if they had used its constant as calibrated for hard x-rays it would have indicated nearly four times the radiation intensity actually there.

These gamma-ray measurements concern the amount in a beam of radiation. Measurement of a roentgen ray can be done in the beam with good precision within a few per cent. However when radiation enters the body it is augmented by scattering or

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30, Dec. 4, 1931.

rather, its absorption is so augmented, for some elements of the tissue are irradiated twice by the same beam, once going in and once scattered back, and the tissue exacts its toll of energy absorbed at each passage. It has become a common practice to measure roentgen dosage at the patient's skin, which includes the back-scattering. The argument for this method is that this is the dosage which is really effective in the patient's tissues (skin, usually), and that it is easier to measure the total than to estimate it from the beam. The augmentation due to scattering depends on the wave length, the distance from the tube, the size of area, and the size, shape, and composition of the part irradiated. However, with the same tissue dose at the surface, the tissue-response, especially the ultimate recovery, may depend on the same things, namely, wave length, distance, area, and part (and also on some others as rate of application, age of the patient, idiosyncrasy), so we have to specify all these things anyhow, for a complete record.

Now I think the measurement of dosage intensity on the skin is much less dependable than measurement of roentgens in the beam. Even in the simple case of the water-phantom it appears that different investigators find signally to agree. Gunsett (3) has shown how error may be produced by change of ionization-chamber constant with change of wave length<sup>2</sup> because the scattered rays are of longer wave length than the incident beam. Also, we must note that the intensity at the center of a large skin area is greater than at the edges, even though the beam is uniform.

The whole problem of scattering with its effect on distribution of energy and alteration of wave length needs more study and needs to be carried into the gamma-ray

range. Also, much more work needs to be done in regard to relation of biologic effect to wave length. Nevertheless, we ought to use what knowledge we have and measure or calculate as best we can the tissue dose in every case we treat. This can be done for radium as well as x-ray and when both agents are used on the same part, the tissue doses can be added to give a notion of the total effect. Tissue dosage, not being uniform, would have to be estimated for critical points, so that a maximum safe skin dose be not exceeded and a minimum effective tumor dose be attained, if possible, throughout.

To sum up, for a precise record of what treatment was given, we should make the record in roentgens. To the end that treatments may be wisely planned and their effects better understood, we ought also to map out the distribution of radiation effect (tissue dose) in the patient. I shall make a separate heading for each of these two complementary ideas.

#### ROENTGENS

A roentgen beam is a stream of radiation. Its intensity is the energy it carries per square centimeter. To measure this energy one must absorb the beam completely. If we absorb only part of it, as in a standard ionization chamber, it will appear more or less intense, according to its absorbability. The international unit, then, is a measure of the product of quantity and absorbability. One roentgen is that amount of x-ray which will produce a unit effect in air. It is not, strictly speaking, a unit of dose for dose concerns effect not on air but on flesh. The latter may parallel the former but it is not identical with it. (I am speaking of immediate effect *i.e.*, ionization.)

A narrow uniform beam of x-ray is used to calibrate a thimble chamber in international r. This step is done at the factory or

<sup>2</sup>For a 400 square centimeter area the total reading of a graphite chamber was 138 per cent compared to the incident beam whereas Duquillier's xenon chamber gave a total reading of 51 per cent of the incident beam.

at the Bureau of Standards. The thimble chamber is set under the tube, port, and filter at the point where the patient will be placed for treatment. Here it measures in air the amount of x-ray per minute that will be applied to the patient when he takes its place. This is, or can be, precise and measures  $r$  by the effect in air, as internationally defined.

#### DOSE

What we are interested in is the tissue dose and I think we would better always call it by its full name—"tissue dose."

A given amount of x-ray (roentgens) of a given quality applied at a given anode-skin distance to a given area on a given part of the body will produce a given tissue dose. If it is a solid part of the body, we can calculate from water-phantom data, if it is a heterogeneous part (like the chest), we can make shift by using our same thimble chamber, but we must not delude ourselves into thinking we are measuring the dose—we are measuring only the amount of x-ray in the neighborhood from which we can judge more or less accurately the tissue dose.

If we are to keep thinking straight, I believe it is important that we reserve the word "roentgen" for amount of x-ray measured in air (in the beam), and so we must find a differently named unit for tissue dose. Dauvillier (4) suggests "ergs per cubic centimeter." The Memorial Hospital clings to "erythema dose." The former seems too precise for a thing we know so uncertainly (in absolute units), the latter seems a bit lacking in precision. I think it would be well to give to the Standardization Committee of this Society the task of defining and naming a unit of tissue dose that may be satisfactory.

#### CONCLUSIONS

The roentgen is not a unit of tissue dose. It is a unit of amount of roentgen ray pro-

ducing a defined effect in air. It should be measured in the beam.

A proper record of a roentgen treatment will embody the following data:  
 $r$  applied (in the beam),  
 quality (half value layer in copper, or for softer ray, in aluminum),  
 area and part treated,  
 anode-skin distance,  
 rate of application (or total duration of exposure),  
 estimation of tissue dose for skin and depth.

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#### DISCUSSION

DR. GEORGE E. PRAHLER (Philadelphia). I have been deeply interested in the subject of dosage from the time measurement was by means of the Sabouraud-Noire pastilles up to photographic strip paper. I prepared an article on this subject many years ago and then I was one of the first to get the iontoquantimeter, of which I have had four.

I must admit that while the whole idea appeals to me tremendously, I do not feel that these iontoquantimeters as prepared and distributed to us are quite what they ought to be for practical radiologists such as we are. I have at the present time three of the very best iontoquantimeters. One of them is out of commission because of the insulation but the other two are supposedly in first class working order. These two were measured within two weeks against a third which was measured at the Bureau of Standards. All three were supposedly measured in  $r$  units, one of them by the German Bureau of Standards, the other two having been checked against instruments measured at the Bureau of Standards in this country. Yet these three instruments put in the same field of irradiation give markedly different readings.

That does not condemn the instrument. It just means that we have not quite brought the iontoquantimeter into the practical field in which we, as untrained physicists, must work with it. The idea is correct, and surely we are approaching more and more to exact dosage, which must be our aim. I have learned in my own laboratory, for instance, just about what I can do to cause a certain biologic effect, but it is still difficult for me to carry over to the rest of you the idea of just what I am doing. That is the object of the r unit. Whether we measure a dose in Philadelphia, or St. Louis, or Paris, or Stockholm, that r unit should be the same. When we give 650 or 700 r units, which would perhaps be our interpretation of the average erythema dose, that should mean just the same in each of these places, and until it does do that, we have not quite accomplished our object. We will succeed. It is only a matter of the physicists checking over these instruments and telling us what errors we are making, or correcting the errors in the instruments themselves.

DR G. FAILLA (New York City). Dr Newell's paper is very important and timely because it focuses our attention on a subject about which considerable confusion exists. This confusion was brought about by introducing a unit of  $\lambda$ -radiation before it had been properly worked out, especially in regard to its limitations, and before the profession was technically equipped to use it. The situation, however, is much better to-day than it was a year or so ago.

We know from Dr Taylor's report to this Society that there is close agreement among the independent determinations of the roentgen or r unit, made in the national laboratories of England, Germany, France and the United States. Accordingly, we are sure now that instruments can be calibrated properly in these countries. But the radiologist is interested primarily in the calibration of his own instrument. Better he is interested in the permanency of this calibration after the instrument leaves the Bureau of Standards. I have heard of several instances in which a radiologist who placed two or more instruments

in the same beam of  $\lambda$ -rays has obtained a different value of the intensity with each instrument. The discrepancy may be 25 per cent, or even 50 per cent. Naturally, this is disconcerting to the radiologist and he is apt to lose faith. In the near future, this trouble will be eliminated entirely, either by the introduction of new instruments, which maintain their calibrations, or by the provision of a radio-active standard with each instrument. The radiologist can rely on the physicist to solve this problem.

The radiologist must solve for himself the problem of the proper use of the unit. He must first familiarize himself with its significance and its limitations. The roentgen or r unit, represents a certain *quantity* of  $\lambda$ -rays, just as the ounce represents a certain quantity of a drug. A treatment specified by stating only the number of roentgens administered is meaningless, because the effect produced depends also on other factors. A dose of radiation should be specified in such a way that any experienced radiologist can form a definite idea of the biologic effect to be expected. No one can predict what biologic effect will be produced in a patient by the administration of 1,000 r without knowing also the type of radiation used, its distribution within the body, the length of time during which it was administered, etc. It is important, therefore, to have in mind at all times all the factors which influence the biologic effects of radiation.

In radiotherapy, in which we always deal with complicated systems, this is not a simple matter. In general, we have one tissue (tumor) which we wish to destroy, and one or more tissues which we must not damage permanently. A knowledge of the distribution of radiation within the tissues which must necessarily be irradiated is, therefore, absolutely essential, but it is by no means sufficient.

For the purpose of the present discussion, I shall dwell on only one of the many difficulties which Dr Newell has in mind. The biologic effectiveness of a certain quantity of radiation, expressed in r, varies with the quality of the radiation. Thus the erythema dose for unfiltered low voltage  $\lambda$ -rays is about 300 r for highly filtered 200 K V  $\lambda$ -rays it is



600 r, and, for gamma rays, Dr Glasser estimates it to be 2 000 r. When hard rays of a definite quality, determined in air, strike the tissues, the quality is changed considerably, the change being more marked at greater tissue depths. This brings about a change in biologic effectiveness, and, therefore, the same number of r at the surface of the body, and at a considerable depth below, have not the same biologic potentiality, so to speak. The situation here is somewhat analogous to the simultaneous irradiation of the skin with a combination of x-rays and gamma rays. Suppose that the x-ray tube target contains 10 gm of radium. The intensity of the combined beam of gamma and x-rays can be measured in r per minute by means of an ionization instrument, but we would not be able to determine from this the length of the exposure required to produce an erythema.

It is with the idea of circumventing these difficulties that Dr Newell suggests that the use of the unit be limited to the specification of the intensity of the x-ray beam in air without the disturbing influence of the patient's body. Then he suggests that some other unit be adopted for the specification of tissue dosage. I am inclined to agree with Dr Newell in his first proposal, at least to the extent that the intensity of the x-ray beam measured in air should always be stated, irrespective of any other measurements which may be made during a treatment. But the introduction of an additional unit at this time is highly undesirable. In the first place with our present knowledge we cannot devise a unit for tissue dosage which is satisfactory especially if the same unit is to be used for both x-ray and ra-

dium treatments. Any unit we can think of involves the same fundamental difficulties as the r unit. This applies both to physical and biologic units.

Experiments are now in progress which will throw considerable light on this problem. It is desirable, therefore, to await the outcome of these before we consider the adoption of a new unit, which may have to be discarded later. If, with some well understood limitations, the r can be used in practice for measurements of both radiation emission (intensity at a certain point in air) and tissue dose it will be preferable to the use of two separate units. While awaiting a practical solution of this problem, the radiologist should always determine the x-ray emission of his apparatus in terms of the r unit. This will enable him to duplicate treatments with the least uncertainty, and will make his technic intelligible to others. After all, the r was introduced in order to serve these two purposes, and it does that very well. Later if it is found that it can be used for other purposes, so much the better.

DR NEWELL (closing). I have had a great deal of conversation about this matter since I came to the meeting. They tell of Cecil Rhodes that one of his friends accused him of changing his mind on some subject. He admitted the charge and said: "Yes I changed my mind as quickly as I could because I found out that I was wrong." I have written the paper over three times since I left San Francisco—that is only a measure of my belief that it needs more argument and discussion.

# ROENTGENOLOGIC EXAMINATION OF THE DIGESTIVE TRACTS OF INFANTS AND CHILDREN<sup>1</sup>

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**I**N a very young infant, or an unruly older child, it may be necessary to administer the opaque meal through a catheter or stomach tube. In order to facilitate this procedure, as the mixture is usually too thick to flow quickly through a tube attached to a funnel, the meal may be introduced through a syringe attached to the end of the stomach tube. Infants able to nurse from a bottle may have the opaque meal given in this way, using the ordinary feeding formula and adding to it one part of barium sulphate to about eight parts of food. The quantity of food administered is about that of an average feeding for the age of the child. In children over two years of age a mixed feeding may be given, such as a cup of cocoa and a dish of cereal to which has been added one part of barium sulphate to eight parts of the substances used. Some children can be tempted to take the barium in ice cream. Occasionally, an older child will take the ordinary barium sulphate cream used in the examination of adults.

Whatever food is given it is advisable to observe fluoroscopically at least a part of it as it passes through the esophagus in order not to overlook a lesion in this region such as stricture or cardiospasm. The filled stomach is studied fluoroscopically for evidence of pylorospasm and for the character of the peristaltic waves. The stomach is usually palpated in an endeavor to fill the duodenum. However this organ *rarely shows the typical caplike appearance in very young children*.

A colon injection is then given using the

same kind of opaque mixture that is used for adults, but in quantity proportionate to the size and age of the child. In a case of megacolon, which may have been disclosed in the course of the opaque meal examination, an unusually large amount of injection may be required. This may be determined by watching through the horizontal fluoroscope the injection flow into the bowel. Stereoscopic roentgenograms are made in the prone position, followed by single or stereoscopic exposures in the vertical position. In unusual cases, these may be supplemented by oblique or lateral exposures.

The child is then allowed to *eliminate the injection*. The amount of retention in the colon and the condition of the ileocecal valve are noted in exposures immediately after the elimination. In cases of dilatation of the cecum, the emptying of the sigmoid will allow the cecum to be observed much more clearly and remove all doubt of the shadow produced by an elongated sigmoid passing far to the right and overlapping the cecum.

Special study of the appendix may be made at 24-hour intervals, until it is empty.

Among congenital anomalies of the esophagus one of the most important is the type of atresia in which the lower end communicates with the respiratory tract, while the upper end terminates in a blind pouch. In view of the communication with the respiratory tract it is evident that the performance of a simple gastrostomy is not sufficient to save these children. It is essential that the cardiac orifice of the stomach be tightly closed in order to prevent food from passing into the bronchi and causing pneumonia. Possibly a jejunostomy may accomplish a result more favorable than gastrostomy.

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1911.

Later on, a plastic operation may be resorted to, in order to make a new esophagus out of a portion of the stomach, as has been done successfully after the removal of an esophageal tumor in an adult

line, from which a narrow, tortuous channel emerges

*Cardiospasm*, which has also been described as idiopathic dilatation of the esophagus may be of congenital origin Dr



Fig 1 Congenital hypertrophic pyloric stenosis Male 8 weeks of age Duration of symptoms, two weeks Clinical diagnosis pyloric stenosis or pylorospasm Radiographic examination showed typical appearance of congenital hypertrophic stenosis Stomach dilated (A) and at the end of 50 minutes none of the meal had passed through the pylorus (B) An immediate operation was advised but death occurred before preparations were completed It is felt that if this case had been treated at the onset of the trouble a successful diagnosis could have been made in time to have secured a favorable operative result

Unfortunately caustic substances such as lye, which is the basis of many cleansing preparations are easily obtained by the public A mother sometimes does not appreciate the danger of leaving one of these preparations open within reach of a child Dr Chevalier Jackson has repeatedly warned against this danger and has obtained successful legislation in many States requiring proper labels to be placed on such cleansing preparations as contain lye

Strictures of the esophagus due to the swallowing of caustics usually occur in the middle third and have a fairly characteristic appearance on roentgen examination The upper portion of the esophagus appears dilated and ends in a more or less oval out-

Jackson claims that the condition generally known as cardiospasm is due in many instances to the failure of the diaphragmatic pinchcock to open at the proper moment in the deglutitory cycle We have observed three such cases in children In cardiospasm the opaque mixture is seen to pass down to the cardia at which point it stops A roentgenogram made at this time preferably in the oblique position will show the outline of the esophagus to be smooth and regular contrasting with the ragged shadow typical of newgrowth The lower end of the esophagus will taper rather than end in an oval pouch as is observed in strictures from swallowing caustics Usually it will be uniformly dilated above

As early as 1912, it was suggested that it seemed only fair to obtain early a series of roentgenograms in every questionable case of *hypertrophic pyloric stenosis* (Fig 1), so that the infant suffering from a true pyloric stenosis, with an obstructive tumor at the pylorus, might be referred to the surgeon while its physical condition was still good

In a case with a palpable tumor in which on repeated roentgen examination, there is a retention after three hours of the greater portion of the meal, surgical intervention is indicated, and the operation will not have been materially delayed. The roentgenograms afford a graphic demonstration to the pediatrician, who may find it expedient to utilize them in convincing the parents of the need of operation. Many lives have been lost through delaying operative relief until the child's resistance is so lowered that there is not sufficient vitality for him to react from operation.

Attention is called to the fact that roentgen examination demonstrates that the Fredet-Rammstedt operation is more desirable from a physiologic standpoint, inasmuch as the stomach empties at about a normal rate after the operation. After a gastro-enterostomy it usually empties at a much too rapid rate.

Roentgenographically considered, the term "pylorospasm" is used to indicate a pylorus which remains continuously closed for an unusual length of time after the ingestion of food, then relaxing or one which intermittently opens and closes in an irregular manner. In either case there is apt to be a gastric retention beyond the normal emptying time. The cause of this condition can be ascertained readily in most cases. Pylorospasm will most often be found in children of spasmophilic tendencies. It may be entirely independent of the character or quantity of food ingested. We have observed in certain cases in which there is a

mechanical derangement in the lower portion of the intestinal tract that there has been a corresponding delay in the emptying time of the stomach. This is borne out by experimental evidence. Because the older theories in regard to the acid control of the pylorus have been largely discarded in favor of direct control by the pyloric muscle itself, we are inclined to believe that there is some intrinsic lesion present.

Cases of pylorospasm in older children usually come to the roentgenologist for study on account of recurrent attacks of vomiting, so-called "cyclic vomiting."

The typical roentgen findings of pylorospasm are about as follows. On the administration of an opaque meal the pyloric end of the stomach fails to fill. After several minutes this region fills out, but nothing passes through the pylorus. (We refer to the unpalpated stomach, for, under forcible palpation in front of the fluoroscopic screen, some food may be pressed through the pylorus.) If roentgenograms are now made at intervals of 15 or 20 minutes no food will be observed to pass through the pylorus until, perhaps, after from 45 minutes to one hour. From this time on the pylorus may function in a fairly regular manner, so that, at the end of the average emptying time, only a slight retention may be present. In other cases, the pyloric aperture becomes spasmodically closed and does not relax again for another interval of from 45 minutes to an hour. In this type of case there will usually be a large gastric retention.

A considerable number of cases of recurrent vomiting have been entirely relieved by the knowledge afforded by a roentgen examination (Fig 2). Defective intestinal mechanics and the associated pylorospasm are apparently indirectly responsible for the acute manifestations such as fever and vomiting. The acetone breath and acetonuria due to temporary starvation gave occasion in the past to the diagnosis of

acidosis in these cases. To the best of our knowledge, these patients never showed air hunger or the extreme prostration associated with true acid intoxication. The fact that after the establishment of suitable

That *gastroptosis* is frequently a congenital condition or that at least the tendency to the condition is congenital, is shown by the illustration of a mother and two daughters all of whom had a marked degree

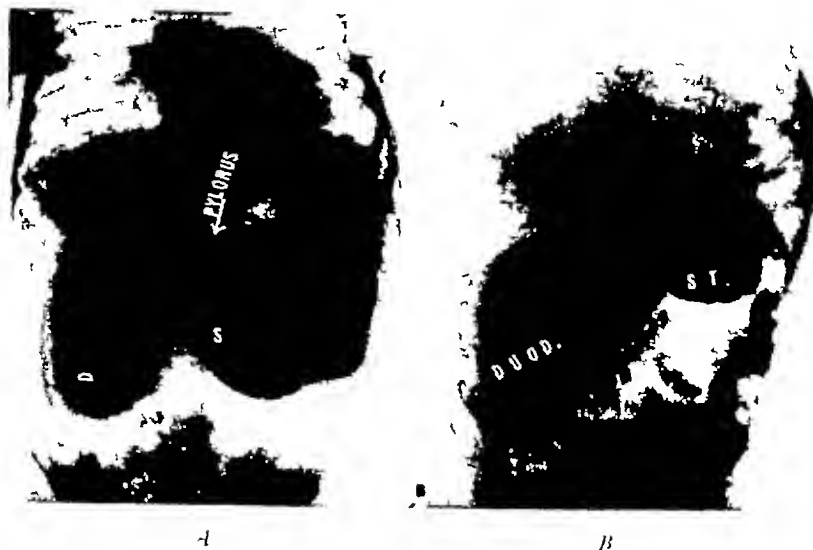


Fig 2 Congenital dilatation of duodenum. Male 4 years 6 months of age. Periodic vomiting abdominal distention. Radiographic examination showed an enormous pouch to the right of the stomach and equal to it in size (A). The stomach was almost empty at the end of six hours, but the duodenum was more distended than before (B). The duodenum was still filled at the end of 24 hours. Diagnosis of dilated duodenum due to congenital obstruction was made. Successfully operated upon by Dr W A Downes.

treatment, no recurrent vomiting seizures have occurred would make us believe our diagnosis to be correct.

Prior to the use of the roentgen ray it was generally believed that in an adult the normal position of the greater curvature of the stomach was considerably above the level of the umbilicus. This was substantiated by laparotomy. For at operation, the patient is in the recumbent position. In the vertical position however a roentgenogram will show that the greater curvature may at times be several inches below the iliac crest. In a child this would be considered pathological. Therefore the only definite way of knowing the exact position of the stomach is by roentgen study in the vertical position.

of ptosis. It would be wise to examine for this condition more frequently particularly if it be known that one member of the family has gastroptosis.

Grave *splenic* lesions are so frequently seen in children that it would seem advisable to keep in mind the possibility of this disease involving the gastro-intestinal tract. It is quite possible that such cases have been overlooked in the past.

The roentgen findings may be classified as follows:

1. Dumbbell-shaped deformity due to infiltration of the middle of the stomach. This must not be confused with an hour-glass deformity which has an extremely narrow passage between the upper and lower

pouches In syphilis, the diminished capacity of the stomach is usually compensated for by a dilatation of the esophagus

2 Diminished size, without the dumb-bell-shaped deformity In this type there is apt to be a rapid emptying, due to contractile failure of the pyloric sphincter In spite of this, there may be a retention at the cardiac end at six hours, since the infiltrated wall is unable to function properly

3 Involvement of the pyloric region somewhat similar to that of ulcer, causing stenosis with a resultant delay in emptying and dilatation of the stomach

4 Filling defect about a portion of the stomach other than the pyloric end In these cases the findings resemble those of newgrowth

It is believed that dilatation and ptosis of the *cecum* have a congenital origin The symptomatology has not been recognized in childhood, the associated digestive disturbances having been attributed to so-called acute indigestion, due to errors in feeding, or otherwise To diagnose this condition requires not only a study by means of an opaque meal, but also by means of an opaque injection of the colon after the colon has been carefully emptied

An *appendix* which fills with barium and empties readily does not deserve special consideration, but one which retains the opaque material *several days after the meal has been eliminated* from the colon is more than likely to be pathologic These facts have been borne out in a series of cases operated upon successfully

The presence of concretions in the appendix may be occasionally demonstrated without the aid of an opaque meal However, one must distinguish between a concretion a ureteral calculus and a calcified gland, any one of which might cast a shadow in the right lower quadrant A segmented appearance of barium in an appendix is probably due to the presence of concretions which have become coated

Erroneous diagnoses of *acute* appendicitis have been made, and patients operated upon, in mistake for pneumonia on the right side The physician must remember that pain associated with pleurisy or pneumonia may be referred to the iliac region

Elongation or redundancy may occur in any portion of the colon, though the most frequent site is in the pelvic colon The most evident symptom of a redundant (congenitally elongated) colon is that of fecal retention The child comes to us with the history of persistent constipation requiring daily use of drugs or enemas However, the condition may give no symptoms In other cases, the elongated bowel may produce serious symptoms, namely, those of partial obstruction, intermittent in type or complete obstruction from volvulus We have found that pylorospasm is frequently associated with elongation of the colon<sup>2</sup>

*Megacolon Congenital Dilatation of the Colon Hirschsprung's Disease*—Roentgen examination not only makes or confirms the diagnosis in this condition, but, by means of a careful study, will frequently reveal the fact that the dilatation does not involve the entire colon It may, for example, involve only the descending colon and sigmoid flexure In other cases, the dilatation may involve separate portions of the colon, such as the hepatic flexure splenic, or sigmoid flexure, or all three of these regions (Fig 3)

*Intussusception*—In a case of suspected intussusception, roentgen examination will in all probability, locate the site of obstruction Without even the administration of any opaque substance, roentgenograms may reveal distended loops of intestine which, owing to the peculiar structure in the various regions may lead to an identification of the intussuscepted bowel (Fig 4)

*Volvulus*—Cases of congenital dilatation of the colon especially those associated with redundancy in the region of the sigmoid are

<sup>2</sup>This may be of considerable importance in connection with the new nerve resection operation for megacolon



Fig 3 Megacolon in a male, 7 years of age. The patient had been extremely constipated since birth. X-ray examination showed enormously dilated hepatic, splenic and sigmoid flexures. There was bilateral eventration of the diaphragm.

liable to suffer from volvulus. If the condition does not yield to medical treatment, it may be necessary to perform a laparotomy and relieve the volvulus by untwisting the loop of sigmoid. The operating surgeon might well consider the advisability of a radical operation, if the patient's condition permits of it.

The peculiar development of *non-rotation* of the colon has been encountered by us in 12 subjects. In this condition the cecum is found as a rule, on the left side but it may be in the median line. Attention is called to the fact that the duodenum does not pass behind the transverse colon, passing instead directly to the right in almost a straight line, merging with the jejunum. On this account the usual cap-like formation of the first part of the duodenum may not be evident. Lack of familiarity with this anomaly may lead to a wrong interpretation.

Roentgen examination has proved definitely that there is in the stomach of every child, a variable amount of gas, derived from one of three sources, namely swallowed air, gastric fermentation and intestinal air, of which the first is by far the most common. A large amount of gas in the stomach at the time of feeding will almost invariably cause eructation or vomiting because of excessive distention.

*Hernia of the diaphragm* is congenital in a large number of cases, though it often is not recognized until late in life. In many instances there is a history of trauma and it is supposed that this has been the cause of the hernia. However, while this may occur, yet in many cases the hernia has been present, but unrecognized. The stomach may actually develop within the thorax, the esophagus entering the stomach above the diaphragm. On the other hand, in acquired hernia of the diaphragm, the esophagus enters the stomach below the diaphragm.

In some cases designated as "thoracic stomach," the entire stomach remains in the chest cavity, in others, part of the stomach is in the thorax and part in the abdomen. The latter is apt to cause attacks of partial obstruction. In addition to the stomach, the splenic flexure or other portions of the digestive tract may be in the chest cavity. We have studied two cases of hernia on the right side in which the hepatic flexure had passed through the diaphragm. A hernia may protrude through a dilated esophageal opening. The mere presence of the stomach in the thoracic cavity is not in itself incompatible with the enjoyment of good health and longevity, provided the stomach functions normally. In one case of a woman 69 years of age whose clinical diagnosis was carcinoma, there was present a congenital hernia of the diaphragm (thoracic stomach). Though she had been subject to intermittent attacks of pain for 30 years at the time of examination her physical condi-

tion was exceptionally good. When asked to locate her pain, she placed her hand over the lower part of the chest exactly where the roentgen examination showed the stomach to be.

*Tuberculous peritonitis* is often suggested roentgenographically by a delay in the passage of food through the small intestine, the presence of dilated loops in this region of the bowel, with a peculiar tendency to pocketing of food in these loops, and by findings suggestive of adhesions between parts of the small intestine.

In *tuberculous enteritis* one would expect to find unusually rapid progress of the opaque meal through the intestine in view of the presence of tuberculous ulceration. However, the ulceration may cause infiltration and stenosis which would result in a delay in the small intestine.

The tuberculous ulcers may be accompanied by localized tuberculous peritonitis causing adhesions. This might produce localized areas of dilated loops of small intestine.

*Transposition of the viscera* is much more frequent than was previously thought to be the case. This is due to routine roentgen studies, for former cases were seen only by chance at autopsy. The author has encountered 39 cases, the youngest being four months of age.

As a rule if one viscus, such as the heart, is transposed, the other viscera are also transposed. The transposition is usually so complete a reversal of the normal that care must be exercised always to mark roentgenograms in such a manner that the right and left side can be definitely identified. This is especially true since the use of double-coated films has become so general. Previously, one could determine the right and left from the emulsion side of the plate knowing the position in which the exposure was made.

It is possible to have a combination of transposition of the viscera and non-rotation of the colon. The appendix would then be



Fig 4 Intussusception. Male 16 months of age. Symptoms of intestinal obstruction of 24 hours' duration. There was no palpable mass. Clinical diagnosis suspected intussusception on the left side. Radiographic examination disclosed intussusception of the terminal ileum into the cecum. The injected opaque material when it met the intussuscepted portion of the ileum spread out over it in a thin layer. A small incision was made directly over the cecum; the intussusception was reduced, and complete recovery resulted.

in the mid-line or on the right side, in spite of the transposition. While the occurrence of this anomaly has not been personally observed, reports of two cases have been brought to the writer's attention which, from the description, would lead one to believe they represent this condition.

A case of displaced heart should never be mistaken for transposition. Roentgen evidence is usually conclusive on this point, first because the cause of the displacement, in this instance a pneumothorax, is usually evident, secondly, a transposed heart is, as a rule, accompanied by transposition of the stomach. The location of the stomach may be definitely determined by means of an opaque meal or simply by the presence of gas in the cardiac end.



The correct diagnosis of abdominal tumors may be greatly aided by careful roentgen examination. While it is occasionally necessary to have a combined urologic and roentgen examination, it is rarely necessary to produce an artificial pneumoperitoneum or perirenal emphysema.

In a given case of palpable abdominal tumor, the roentgenologist usually starts the examination with anterior and posterior roentgenograms before the administration of an opaque meal in order to determine the presence of calcified deposits or dilated areas of the digestive tract. The opaque meal is then carefully followed to determine the possible relationship of the tumor to the digestive tract. Certain tumors produce characteristic displacement, i. e., an enlarged spleen displaces the splenic flexure downward, while tumors of the kidney displace the descending colon forward and inward.

*Foreign bodies* may lodge in the pharynx or esophagus of an infant or young child, remaining there for some time unsuspected, unless the swallowing of the foreign body has actually been observed. The child may refuse his food, appear restless, and have a more or less spasmodic cough. In any obscure case of this sort, a roentgen examination should be made as metallic foreign bodies are so easily detected. In the absence of a shadow of a metallic foreign body the symptoms may be persistent enough to warrant an esophagoscopic examination which may disclose a non-metallic foreign body as the cause of the symptoms. On the other hand the foreign body may pass directly into the stomach.

Foreign bodies may be divided into two classes:

1. Those which are more or less harmless and may be roentgenographed from day to day in order to watch their progress through the intestinal tract. Under this heading are included coins, buttons, cloed safety-pins, etc. the immediate removal of which is not imperative.

2. Foreign bodies such as needles, open safety-pins, and all pointed metallic substances, if repeated roentgen examinations show that they remain in the stomach for several days, should be removed through the gastroscope or through a gastrotomy opening.

The successful passage through the pylorus of foreign bodies which have one sharp and one blunt extremity is accomplished by the blunt end passing first. If the point attempts to pass first through the pylorus apparently a strong spasm is set up which prevents the point passing further. The alternate relaxation and contraction of the stomach then tends to perform a "version." When the *blunt* end finally reaches the pylorus it is allowed to pass. This mechanism has been observed in a number of cases.

If the foreign body passes through the pylorus, it will in most instances, successfully pass through the remainder of the digestive tract *but this can never be taken for granted*. A long metallic foreign body may lodge in the duodenum and removal is demanded if it appears to remain stationary for several weeks. Delay as long as two weeks may be observed about the cecal region before the onward movement of the foreign body finally occurs. If after two weeks no change is observed in the position of a foreign body in a roentgen examination, operative intervention is usually advisable. Round or short pointed objects sometimes lodge in the appendix. Three cases of birdshot have been observed in the appendix and several patients with pins.

Another foreign body in the stomachs of older children and young adults, which can hardly be classified with either of the preceding groups is a *hair-ball*. This condition is usually the result of a habit of pulling out individual hairs and swallowing them.

A case was recently encountered of a foreign body in the stomach, the patient denying any knowledge of when or how it had

been swallowed. On removal through the gastroscope, the metallic foreign body was found in a condition that would indicate its presence in the stomach for a period of perhaps many months. In commenting on this case Dr. Chevalier Jackson has written to me assuring me of his belief in "the necessity of every man, woman, and child having an x-ray examination periodically as part of the general examination every year."

#### CONCLUSIONS

1 Every newborn baby should have an x-ray examination made of its digestive tract as well as of its heart, lungs, and osseous system, including the skull.

2 A periodic health examination is never to be regarded as complete unless it is accompanied by an x-ray examination.

3 Before undertaking a surgical operation for supposed chronic appendicitis, an x-ray examination is advisable in order that the location of the appendix, or at least the cecum, may be determined, as over 50 cases of left-sided appendix have been observed by the writer. Furthermore definite information may be obtained confirming the diagnosis of chronic appendicitis, or some other condition may be found to account for the symptoms and make surgical intervention unnecessary.

## DIAGNOSIS OF EXTRA-GASTRO-INTESTINAL ABDOMINAL MASSES<sup>1</sup>

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THE determination of the presence, size, shape, position, and origin of a mass in the abdomen is a problem which has always intrigued medical men. While in some cases the answers to these questions may be readily obtainable from the history and physical findings, frequently these methods alone are insufficient. Hardly a more difficult task faces the clinician than that of deciding whether or not he feels an abnormal mass and if so whether it is intra- or retroperitoneal in situation, pelvic or upper abdominal in origin, and to which organ it is attached.

This diagnostic problem, no doubt, led to the discovery and use of pneumoperitoneum in roentgen diagnosis. It has led to many other methods of rendering an abdominal viscus or mass visible by the use of contrast

media. The roentgen visualization of the gastro-intestinal tract, the urinary tract, the gall bladder, the uterus and tubes, and now the liver and spleen have all been steps in the advancement of the diagnosis of abdominal masses.

The most recent development, the rendering of the liver and spleen opaque to the roentgen rays by the intravenous administration of thorium dioxide in colloidal suspension, holds forth great promise in this direction. If the accurate determination in the roentgenogram of the liver and spleen can either eliminate them from consideration or demonstrate either as the source of a palpated mass, a great deal will have been accomplished. In our limited experience with this method, a number of obscure cases have already been clarified in this way. Obviously, the procedure has numerous other applications, such as the study of the func-

<sup>1</sup>Presented before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

tion of the liver and spleen, the effects of disease upon these two organs, and many others, but not the least part of its value is the clear outline of the liver and spleen which may now be obtained



Fig 1. Markedly enlarged spleen in case of myelogenous leukemia. The medial border of the spleen can be outlined by the shadow of the greater curvature of the stomach. The latter is displaced markedly to the right but a small portion (arrow) protrudes to the left obviously projecting into the splenic notch. This is an exaggerated picture of the characteristic displacement of the stomach by an enlarged spleen. (Confirmed clinically.)

The intraperitoneal injection of gas is no doubt, the most valuable and accurate method of demonstrating an abdominal mass. The objections to it lie in the fact that it is not a simple procedure, involves considerable distress for the patient, and is not en-

tirely without risk. Nevertheless, when simpler methods fail, it should be resorted to, by all means. The simplest procedure which is helpful consists of the roentgen study of the gastro-intestinal tract with the use of an opaque medium.

In many cases the examination of the stomach and bowel with the barium meal and of the colon with the barium enema or by air inflation, is sufficient to give data leading to the accurate diagnosis of an abdominal mass. In view of the fact that in most cases this examination would, in any event, be made to rule out the gastro-intestinal tract as a source of the tumor, it is surprising that not more has been written concerning this method of diagnosis. Reference to it in text-books is meager and the only recent papers in English on this subject are those of Butler and Ritvo (1) and Brown (2). The former have covered the subject most completely while Brown has emphasized the importance of the lateral view.

The method of procedure consists in the roentgenoscopic and roentgenographic examination of the stomach and bowel after a barium meal at frequent intervals and in numerous positions, both upright and prone. The roentgenoscopic examination permits manipulation of each individual case to the best advantage and films are then made in the positions best calculated to demonstrate the abnormality which is present. The same method is used in the examination of the colon, the barium enema being not infrequently supplemented by inflation with air. The latter often permits a more accurate delineation of the mass, the density of which stands out in sharp contrast to the surrounding gas-filled bowel. Frequently, especially in children, sufficient gas is present spontaneously in the colon to enable delineation of a mass in the roentgenogram without further manipulation.

Abdominal masses, whether they be enlargements of an abdominal viscus or ex-

traneous tumors, will usually produce some deformity or displacement of that portion of the gastro-intestinal tract with which they are in contact. Obviously, considerable increase in the size of the organ must occur

colon, while a normal gall bladder may produce a distinct impression on the duodenal bulb. The urinary bladder, when filled, often displaces the small bowel out of the pelvis and may thus be mistaken for a pelvic



Fig 2-A (left) Congenital cyst of liver. The enormous size of the liver is well shown by the displacement of the hepatic flexure and transverse colon into the pelvis. The size of the liver can be fairly well made out by the contrast of the spontaneously gas-filled colon (arrows). (Confirmed at operation)

Fig 2-B (right) Same case after surgical drainage. Only a small remnant of liver substance remained but this rapidly regenerated. The changing size of the liver could be readily followed by observing the position of the gas-filled colon (arrows). At this stage the liver is still smaller than normal.

before this displacement is of sufficient grade to permit visualization. In most cases, however, when symptoms are present, or a mass palpable, the displacement is well marked. In fact, during the course of a routine examination of the gastro-intestinal tract, we have frequently been enabled to call attention to the presence of an extra-gastro-intestinal mass which was entirely unsuspected clinically. It must, of course, be borne in mind that normal abdominal organs may produce distinct impressions upon the stomach or bowel. The normal spleen, for example, particularly in asthenic individuals, frequently indents the greater curvature of the stomach or the splenic flexure of the colon. Likewise the normal liver may compress the hepatic flexure of the

tumor. The estimation of whether or not the degree of displacement is abnormal is a matter of judgment, although in most cases no great difficulty is experienced. A knowledge of the normal position and the relationship of the solid abdominal organs to the gastro-intestinal tract and peritoneum is necessary in order to properly analyze the character of the displacement and deduce therefrom the nature of the mass which is causing it. Furthermore, it must be considered that various organs when they enlarge tend to extend in fairly characteristic fashions. Thus the spleen while it is a partially posterior organ enlarges anteriorly. The kidney, on the other hand, tends first to enlarge posteriorly. Similar characteristics are manifested by the other organs.



Fig 3 Hydrops of the gall bladder of large size. The stomach (1) and duodenal bulb (2) are displaced to the left, the latter being compressed upon the antrum (1) of the stomach. The second portion of the duodenum (3) is displaced to the left. The hepatic flexure (4) is displaced to the right. The area (5) in which no barium is seen represents the gall bladder. Its size, shape and position are thus readily outlined. (Confirmed at operation.)

For the purposes of roentgen diagnosis the abdominal masses may best be classified into four groups as follows: (1) upper abdominal intraperitoneal masses including spleen, liver, gall bladder and tumors in this region; (2) pancreatic tumors, or cysts and retroperitoneal upper abdominal glands; (3) retroperitoneal masses including the kidneys; (4) masses of pelvic origin. In this study tumors arising directly from the gastro-intestinal tract are not considered. Each of these groups exhibits certain characteristics in its displacement and compression of the gastro-intestinal tract. The individual organs or tumors within each group may also have more distinctive manifestations.

It would seem that palpation of the spleen would be undisputed by clinicians, yet in numerous cases arise wherein the distinction between the spleen, the left kidney, a subphrenic abscess and tumors arising from

the peritoneum is apparently difficult. The spleen characteristically displaces the stomach to the right, compresses the greater curvature and may even exhibit its notch by the peculiar formation of the greater curvature of the stomach (Fig 1). The splenic flexure is normally displaced downward but not necessarily so as the spleen may displace the descending arm of the flexure to the right while leaving the superior margin of the colon under the diaphragm. The fact that the spleen is always above and lateral to the colon and that it displaces the cardiac end of the stomach as well as the middle portion, effectively distinguishes it from the left kidney. The left lobe of the liver commonly compresses the anterior wall and the lesser curvature of the cardiac end of the stomach. Tumors arising from the peritoneum may also affect the anterior wall or, if pressing on the greater curvature of the stomach, may permit the splenic flexure of the colon to go untouched, thus distinguishing themselves from the spleen. Subphrenic abscess, while rare on this side, may cause displacement of the splenic flexure. It commonly immobilizes the diaphragm, displaces it upward to a great extent and is less sharply defined than the shadow of an enlarged spleen.

Enlargements of the liver characteristically push the stomach and duodenum downward and to the left while they compress the duodenal bulb and the lesser curvature of the stomach. The clinical distinction of liver enlargements from pancreatic cysts or tumors occasionally produces some difficulty. Lateral views will show the mass distinctly anterior to the stomach and displacing it backward. Enlargements of the left lobe of the liver may produce a striking compression of the cardiac end of the stomach. Enlargements of the right lobe characteristically displace the hepatic flexure downward. In many cases the size of the liver may be delineated with fair accuracy

by this relationship with the colon. For example, in a case of congenital cyst of the liver, which was surgically drained, the exact size of the liver could be followed with considerable certainty by observing the position of the gas-filled hepatic flexure and transverse colon. The original condition in this case is shown in Figure 2-A, the right half of the colon being shown well down in the pelvis, with the dense shadow of the liver cyst above it. After drainage of the cyst, hardly any liver tissue remained, but within a few weeks regeneration took place and the restoration of the normal relationship is shown in Figure 2-B. The colon is here obvious, well up out of the pelvis, embracing the inferior surface of the liver, which is probably still somewhat smaller than normal. The author has been enabled on several occasions to make a presumptive diagnosis of atrophic cirrhosis of the liver in patients who were being examined to rule out carcinoma of the stomach. In these, the greatly reduced size of the liver was obvious by the high position of the hepatic flexure of the colon. Occasionally this flexure passes completely upward to the diaphragm simulating a subdiaphragmatic accumulation of gas. This is due to a posterior displacement of the liver rather than to any decrease in its size and should not be confused with atrophy of the liver. The lateral view will demonstrate in these cases that the colon lies anterior to the liver rather than below it.

While moderate enlargements of the gall bladder may show displacement or compression of the duodenal bulb, the so-called gall-bladder 'seat' is not always indicative of abnormality. Hydrops of the gall bladder, however, may produce a hard, rounded protruding mass which often cannot by palpation alone be distinguished from other tumors. Such a case is illustrated in Figure 3. The tendency to displace the duodenum and intrum of the stomach to the left and the hepatic flexure to the right is here well



Fig 4 Carcinoma of head of pancreas. At this stage, this case was clinically diagnosed as cholecystitis. Note compression of superior surface of bulb (arrow) by enlarged gall bladder. The duodenal curve is widely opened up, the second portion being pushed to the right, the third portion downward while the stomach and bulb are displaced upward and to the left. The tumor is thus clearly outlined. Later actual invasion of the duodenal bulb could be demonstrated. (Confirmed at operation)

shown. The duodenal curve is compressed, in contrast to the effect of tumors of the head of the pancreas which tend to open this curve widely. This case also illustrates an important finding which is usually of considerable significance. There is a complete absence of barium in a portion of the abdomen which normally contains bowel. When the barium meal is given in such a way that the stomach, small bowel and colon are all visualized at one sitting, the conspicuous absence of the contrast medium in any particular part of the abdomen except the right upper quadrant, has often led to the roentgen detection of a clinically unsuspected, abnormal mass.

Omental cysts, while rare, may cause marked posterior displacements of the stomach. These are best observed in the lateral view. The distinction from enlargement of the liver is often very difficult. Mesenteric



Fig 5 Cyst of body of pancreas. A massive filling defect of the middle and pyloric thirds of the stomach is shown. By placing the patient in various positions, the posterior and inferior position of the mass could be demonstrated. The defect changed its form, and filling could be obtained with the patient lying on the right side while peristalsis passed through the whole area. An intrinsic tumor was thus excluded. (Confirmed by operation)

cysts tend to displace the stomach upward and forward, depending somewhat upon the portion of the mesentery from which they arise.

Diseases of the pancreas still remain one of the major diagnostic problems which confront the physician. Frequently, however, tumors and cysts of the pancreas give characteristic roentgen findings. Carcinoma of the head of the pancreas tends to cause enlargement of the duodenal curve, the first portion being pushed to the left and upward, the second portion to the right, while the third portion is pushed downward (Fig 4). Obviously, the tumor must attain an appreciable size before this effect is produced. Occasionally actual invasion of the duodenum itself occurs, with a resultant deform-

ity which may be difficult to distinguish from an intrinsic tumor. In Figure 4 is shown an illustrative case, the x-ray findings being present at a time when clinically the diagnosis was quite unsuspected. We have found this displacement of the duodenum of great value in about half the cases of carcinoma of the pancreas which have come under our observation. Many cases of carcinoma of the head of the pancreas show definite clinical findings at a time when no real mass exists, the malignancy infiltrating the organ rather than expanding it. In these cases no roentgen findings will be made out. In a recent case the roentgen findings indicated clearly an enlargement of the liver, while the duodenum was undisturbed. At autopsy a diffuse carcinoma of the pancreas was found, with massive metastases to the liver, the latter being responsible for the roentgen findings. These observations must, therefore, in these cases as in all others, be considered together with all the clinical data in arriving at a diagnosis.

Tumors of the body and tail of the pancreas tend to displace the stomach upward and forward, the transverse colon downward. The normal close relationship of the greater curvature of the stomach and the transverse colon is thus disturbed, the two being separated. Cysts of the pancreas may give a striking picture, as shown in Figure 5, a marked deformity of the stomach resulting. An intrinsic lesion of the stomach could be ruled out by changing the position of the patient, the defect then diminishing in size or disappearing, while peristalsis could be followed through the compressed area. Occasionally, cysts occur in the head of the pancreas and tend to compress the antrum of the stomach as well as expand the duodenal curve. Rarely a pancreatic tumor may extend upward behind the stomach to produce pressure on the lesser curvature. These cases resemble liver enlargements, but the posterior position of the mass can be demonstrated in the lateral view because of the

anterior displacement of the stomach, thus tending to make the distinction clear. I have observed three cases of pancreatic cyst in all of which this anterior displacement of the stomach was most striking.

It seems evident that retroperitoneal lymph nodes of the peri-aortic group, in the upper abdomen, may produce a similar appearance to that described above. Usually, however, the defect in the stomach is not so regular or sharply defined because of the lobulated character that glandular masses assume, but the differentiation of these lymph node tumors from enlargements of the pancreas, by the roentgen examination alone, is often most difficult.

Other retroperitoneal masses, such as kidney tumors and enlargements, adrenal tumors, and retroperitoneal sarcomas, are quite different in that they are more likely to be unilateral and lie well to one side of the spine instead of in the midline, as is the case with pancreatic or peri-aortic lymph node enlargements. While the stomach may be displaced upward and its greater curvature impinged upon by left-sided retroperitoneal masses, the anterior displacement is more striking. The chief effect of this group is to displace the small bowel and colon, depending upon the size of the mass. Most commonly, if the mass is not exceptionally large, the bowel remains in a relatively normal position medio-laterally, but is displaced to a marked degree anteriorly. This can best be demonstrated in the colon either by means of a barium enema or by air inflation. Examination in the lateral or oblique positions will demonstrate the anterior displacement of the ascending or descending colon depending upon whether the mass is on the right or left. This is well demonstrated in the case shown in Figure 6 in which the cecum and ascending colon are compressed and displaced anteriorly by a tumor of the right kidney. If the mass becomes very large it may displace the small bowel completely out of this segment of the abdomen



Fig 6 Hypernephroma of right kidney. Lateral view of colon showing marked anterior displacement of the cecum and ascending colon. The tumor can be well outlined (arrows). Compare with Figure 8. (Confirmed at operation.)

and push the colon medially, or even downward. Downward displacement of the hepatic flexure by a right-sided retroperitoneal tumor of large size may simulate an enlarged liver in the postero-anterior view. The lateral view, as shown above (Fig 6) will normally make the distinction. Occasionally a lateral displacement also occurs but this is much less common. It is notable that on one examination the colon may lie over the mass showing only anterior displacement, while re-examination a short time later may show the colon displaced entirely out of the field occupied by the tumor. Obviously, no sharp distinction can be made in this way between kidney enlargements





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large pelvic tumors tend to extend upward and thus to separate the flexures of the colon and to displace the ascending and descending portions laterally as well as posteriorly. It may be well to emphasize again that these changes may often be observed as well or better by gas inflation of the colon as by the barium enema. Figure 8 illustrates such a case wherein the gas-filled colon and small bowel outline well the upper limits of the ovarian cyst which is displacing them out of the pelvis. In the standing position pressure on the greater curvature of the stomach may also be demonstrated. The cyst of the ovary in this case is flattening the inferior portion of the greater curvature by the pressure exerted upon it.



Fig 8 Cyst of ovary. The pelvic mass is seen displacing the bowel and colon upward. These are distended with gas, and barium is unnecessary to demonstrate the position of the bowel. Note how well the tumor mass is outlined (arrows).

It is necessary to add that many errors creep into this method of diagnosis of abdominal masses. The procedure does not even approach the accuracy of the roentgen diagnosis of intrinsic gastro-intestinal lesions. As has been pointed out above, the rules which have been formulated from a study of a large number of such masses do not always hold. Interpretation particularly of the lateral views, is often difficult. Nevertheless an intelligent application of our knowledge of the anatomy of the abdomen and of the usual behavior of abdominal masses to careful roentgenoscopic and roentgenographic studies of the whole gastro-intestinal tract in different positions will frequently result in the most accurate determination of the size, shape, location and origin of extra-gastro-intestinal tumors.

#### SUMMARY

The roentgen examination of the stomach and small intestine with the barium meal and of the colon with the barium enema or by air inflation is a valuable aid in the diagnosis of extra-gastro-intestinal masses. Occasionally tumors which were clinically unsuspected may be revealed in this way.

The enlargements of the various abdominal organs and abdominal tumors tend to

produce compression and displacement of the stomach and bowel. The character of this displacement depends upon the characteristics of the individual mass. For this reason, the size, shape, origin, and position of a tumor can frequently be determined by its effect upon the gastro-intestinal tract.

The general characteristics of the various groups of abdominal masses and of their individual constituents are detailed. Cases are cited to illustrate how helpful this simple procedure may be in obtaining valuable information concerning many abdominal masses.

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- (1) PETER, P. F. and RITVO, MAX. Extra-bowel Pathology. *Am Jour Roentgenol and Rad Ther*, April 1931, XXV, 474-481.
- (2) BROWN, SAMUEL. Differential Diagnosis of Abdominal Tumors by the Roentgenologic Method. *RADIOLOGY*, January, 1928, X, 48-56.



Fig 7 Sarcoma of right ovary. Lateral view shows marked posterior displacement of cecum and ascending colon (arrows). Note the appendix projecting posterior to the plane of the vertebral bodies (arrow). Compare with Figure 6. This posterior displacement is characteristic of large intraperitoneal masses. (Confirmed at operation)

and other retroperitoneal masses. If, however, the retroperitoneal nature of the mass is clearly established, further investigation by means of intravenous or retrograde pyelography may establish the connection or innocence of the kidney.

Displacement of the ureter is an excellent indication of the retroperitoneal location of any mass. Kidney tumors and other enlargements frequently displace the ureter but other retroperitoneal tumors lying lateral to the ureter also displace it, usually toward the spine. While it is true that very large intraperitoneal tumors may penetrate posteriorly

to a sufficient degree to displace the ureters, this is relatively infrequent, the displacement being likely to measure small in proportion to the size of the mass, and both ureters may be equally affected, the displacement being lateral.

Pelvic tumors, such as arise from the uterus, Fallopian tubes, ovaries, and bladder, are usually quite obvious clinically. Nevertheless, cases arise in which the distinction between a massive retroperitoneal tumor and one arising intraperitoneally from the pelvic organs is extremely difficult. The method of surgical approach and the surgical indications being different, the differentiation becomes of considerable importance.

A filled urinary bladder may be clearly outlined by the displacement of the small bowel out of the pelvis. The pregnant uterus produces a somewhat similar effect. The colon, however, may give a clearer indication. Compression of the sigmoid flexure downward and laterally usually occurs if the tumor arises on the left. The descending colon will be displaced posteriorly and laterally, the transverse colon and stomach upward. If the tumor arises on the right the cecum and ascending colon will be displaced upward and posteriorly. If the tumor is in the mid-line and of large size, such as a myoma of the corpus uteri, both effects may be produced. The lateral view, again, as pointed out by Brown (2), is of great importance particularly in the more massive tumors. A case of ovarian sarcoma is well illustrated in Figure 7. The right side of the colon is displaced posteriorly to a large degree, the appendix being visualized behind the plane of the vertebral bodies. This case may be contrasted with that shown in Figure 6 in which the colon is displaced anteriorly by a retroperitoneal mass. Great care must be exercised in the interpretation of these lateral views because of the superimposition of the descending and ascending portions of the colon in this position. Very

# CHANGES IN SUSCEPTIBILITY OF *DROSOPHILA* EGGS TO X-RAYS

## I A CORRELATION OF CHANGES IN RADIOSENSITIVITY WITH STAGES IN DEVELOPMENT

B<sub>3</sub> P S HENSHAW, Ph D, and C T HENSHAW BS, Biophysical Laboratory, Memorial Hospital, NEW YORK CITY

THAT tissues and organisms differ widely among themselves in radiosensitivity has long been recognized, but comparatively little, it seems, is known of how any one tissue or organism may change in susceptibility to radiation with respect to time or age. While studying the killing effects of x-rays on *Drosophila melanogaster* eggs, certain irregularities in results were obtained. An investigation showed these to be due mainly to the age of the material used. The determination of the significance of the age factor served not only as a foundation for other work in which *Drosophila* eggs were to be used as test material, but also to show how an organism may vary in susceptibility to radiation during development. Since certain stages in the early development of this form are distinct and easily recognizable, it is possible to associate the changes in radiosensitivity with the stages in development and thus ascertain whether or not the nature of the activity going on within the organism is important in determining its response to radiation. At this time we wish to correlate the changes in radiosensitivity with the stages in development and point out the possible influence of the age factor when *Drosophila* eggs are used as test material leaving for a subsequent report a discussion of the kinds of developmental activity associated with the changes in radiosensitivity.

### EXPERIMENTAL PROCEDURE

*Culture of Flies*.—The stock was reared on a molasses-cornmeal medium the same used by Packard (described by Wood (1)

and Packard (2)). The medium was poured into large-mouthed 12-ounce bottles to a depth of about 2 centimeters. Before this mixture was allowed to cool, cellulocotton strips (approximately  $2 \times 4 \times \frac{1}{4}$  inches) were inserted, one to a bottle, so that one end dipped into the cornmeal mass. When the mass congealed, the cellulocotton was held firmly, protruding up along one side of the bottle. This served to absorb the moisture which had a tendency to condense on the walls of the bottles when in use for culture purposes and to give dry rough surfaces for the flies to crawl over. Loosely rolled cellulocotton was used also for stoppers, made long enough to extend well into the bottles. These permitted a free gaseous interchange between the air in the bottles and the outside air, also absorbing the moisture and giving more of a dry surface for the flies. Thus arranged, the bottles were ready for use as soon as the food mass had cooled to room temperature (from 21 to 25° C).

Eggs were collected according to the method to be described below and transferred on moist filter-paper strips to the bottles, each bottle receiving between 300 and 600 eggs. When kept at room temperature the eggs began to hatch in about 20 hours. The emergent larvae grew in size and during the second day after the eggs had been placed in the bottles, the larvae could be seen crawling in search of food. At this time yeast cake (Fleischmann's) was made semifluid by mixing with tap water and 4 or 5 cc were squirted from a pipette onto the sides of the bottle so that

## DISCUSSION

DR SAMUEL BROWN (Cincinnati, Ohio) I have been quite interested in this work for several years and have succeeded in making accurate interpretations of lesions outside the stomach in quite a number of cases in which the usual clinical and physical methods have failed. In my work I depend upon one anatomic characteristic of the stomach—its mobility. The stomach is, relatively speaking, a freely movable organ. Its position will, therefore, depend upon the condition of its neighboring organs. Thus, an enlargement of the spleen will displace the stomach forward and to the right. An enlarged left kidney will do the same, but, in the former, the splenic flexure is also displaced, while in the latter, the splenic flexure remains in normal position. An enlarged right kidney will displace the stomach to the left and forward; an enlarged liver will displace it to the left and backward; an enlarged pancreas or a retroperitoneal tumor will displace it forward. If any lateral displacement is present, the stomach is usually displaced to the left and the duodenum to the right.

DR. N. ENZER (Milwaukee, Wis.) I wonder if Dr. Rigler has had any experience with chilocysts (lymphogenous cysts) of the omentum. Do they produce pressure defects in the stomach or intestinal shadows?

DR. LAWRENCE LITTIG (Madison, Wis.) Both the previous speakers mentioned the displacement of the duodenum to the right and the stomach to the left in tumors of the head of the pancreas. Some time ago I had such a case, and felt sure it was a tumor, or cyst, at the head of the pancreas. However, it proved to be a lipoma of the omentum which gave this typical deformity. Occasionally this will occur.

DR. RIGLER (closing) I think I mentioned that we have used thorium dioxide which

gives brilliant visualization of the liver and spleen, in a limited number of cases. We have not given enough to enable us to draw conclusions as to its eventual value.

We had a case not long ago in which all the clinicians, except one, agreed they could feel the spleen. This spleen, as demonstrated by the thorium injection, was so small they could not possibly have felt it. That is not an uncommon instance.

I did not explain why the patient with mesosarcoma had such acute symptoms. They were due to bleeding into the cyst.

I have seen an omental cyst, not a chylous cyst, which simulated very closely an enlarged liver, and displaced the stomach backward to some extent.

I have used only a small group of the cases which I thought more closely illustrated the type of condition one could meet. I have seen several cases in which clinicians have had great difficulty in distinguishing a large liver and a pancreatic cyst. In our experience this distinction is not easy to make. Because of the posterior displacement of the stomach with the large liver, in contrast to the displacement along the greater curvature of the cyst, we are able to make the diagnosis.

One case in which we thought there was carcinoma at the head of the pancreas, with that characteristic curve, came to autopsy, and we found edema of all the tissues without involvement of the pancreas.

It is difficult to see how a lipoma of the omentum would not manifest itself as in an anterior position, in contrast to the head of the pancreas, relatively posterior. That is the only differential. All of these findings have none of the accuracy of the roentgen diagnosis of carcinoma of the stomach. When we make a roentgen diagnosis of carcinoma of the stomach we are so sure of it that we rely on it almost 100 per cent. In extra-gastro-intestinal lesions, of course, the certainty of the diagnosis does not approach that, but the roentgen diagnosis is helpful when you consider all the other signs.

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it ran down onto the medium. Usually immediate excitement was displayed by the larvæ as they oriented themselves and began to move toward the food. From this time until pupation occurred the larvæ ate

the adult flies emerged. Since the eggs were of approximately the same age, most of the adults appeared within a period of 24 hours. Those slow in emerging were never saved. The young adults were transferred

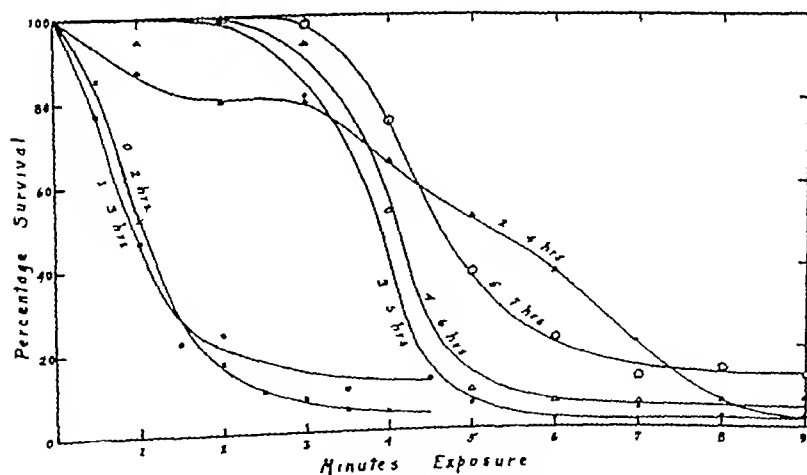
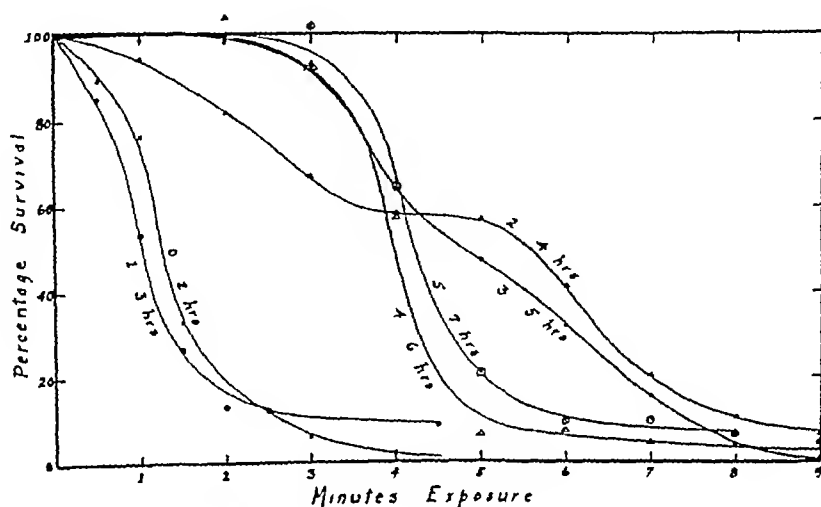


Fig 1 Survival curves for eggs of different ages Exp I

Fig 2 Survival curves for eggs of different ages Exp II

large quantities of the yeast. Since their growth and adult size are dependent upon the amount of food consumed at this time, ample amounts were kept available.

After four or five days in the pupal stage

to fresh culture bottles (from 75 to 150 to a bottle) and provided with what may be called "adult food," since it differs from the yeast fluid "larvæ food." The adult food consisted of two parts of ripe banana and

one part of yeast mixed to form a pasty fluid. Fresh culture bottles were supplied every two or three days.

*Collection of Eggs*—Adult flies from 3 to 6 days old were transferred from three culture bottles to a clean dry bottle which did not contain food. Into this also was inserted a glass slide on which lay a strip of filter paper moist with adult food. The bottle was then stoppered and put away for two hours (horizontal position with moist filter paper directed upward). During this period the flies usually deposited several hundred eggs on the filter-paper strip.

For the experiment it was necessary to have large samples of eggs of different ages. Accordingly, enough collecting bottles were arranged to yield enough eggs for any particular age sample during a two-hour period. By using the same flies repeatedly a sample of eggs was obtained every two hours. To obtain samples every hour a second set of collecting bottles was arranged to alternate with the first. Thus after seven hours' collection, six samples of material were available ranging in age as follows: 0-2, 1-3, 2-4, 3-5, 4-6 and 5-7 hours from the end of the collection period.

Since we were concerned with age relative to development rather than to the end of the collection period and since development begins with fertilization, we were interested in age beginning at the time of fertilization. Because of the nature of the material however it is not possible to state precisely the time of fertilization. In *Drosophila* the eggs are fertilized individually as they pass through the vagina of the female fly. Usually they are laid immediately after fertilization but may be retained for a period. Thus if it were possible to have the eggs fertilized and laid at a uniform rate during the collection period, an average age could be expressed. Two precautions were taken to obtain this condition. (1) No collection of eggs was used unless the flies from which they were ob-

tained had laid actively during a two-hour period preceding the collection period, (2) no collection of eggs was used unless the flies laid actively during the collection period (3 or 4 eggs per hour per female fly). As will be shown later, fairly uniform ages of material were obtained. The average time of fertilization of eggs in a sample was taken, therefore, to be the middle of the collection period.

Each age sample was divided into ten parts so that different amounts of radiation could be given to eggs of each age. Each part, or each small sample, contained between two and three hundred eggs. Since there were ten samples of about 250 eggs each and since six ages were used, around 15,000 eggs were employed for each experiment. All samples, except one of each age (control), were placed in a shallow tray<sup>1</sup> and were thus ready for treatment.

*Irradiation*—The x-ray equipment used was a Victor outfit with a Coolidge water-cooled, tungsten target tube. The tube was operated at 200 K V secondary voltage and 33 ma tube current. The eggs were placed at a distance 35 cm from the center of the target, and a filter of 0.5 mm of copper and 2.45 mm of aluminum was placed directly on top of the tray, approximately 1 cm above the eggs. Before each experiment measurements of the radiation intensity at the place where the eggs received treatment were made with a drum-head ionization chamber. The intensity was 234 r per minute, any deviation from day to day for the above setting being adjusted by changing the tube current. A lead plate shielded the eggs from the rays while the voltage was being built up. Doses were measured by accurate timing from the moment the lead plate was removed. The different exposures were given by stopping the machine at intervals and removing the samples in proper order.

<sup>1</sup>Made by gluing thin celluloid to a wooden embroidery hoop.



TABLE I

Age of Eggs*	Fxp No	Percentage Survival														
Min Exposure		0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	6	7	8	9
5 7 hrs	I	97 4						97 3		61 6		20 0	8 9	8 9	6 4	
	II	90 5						93 2		73 6		36 3	20 6	11 7	13 7	12 1
	III	93 5				93 6		92 2		68 0		14 6	6 2	12 4	9 2	3 6
4 6 hrs	I	96 0				99 1		88 8		54 6		5 8	6 8	4 2		4 3
	II	94 0		90 2		94 6		89 3		50 4		8 9	6 0	5 7		6 7
	III	95 4		94 6		92 9		67 9		31 0		13 5	8 4	3 3	2 4	4 3
3 5 hrs	I	97 0		94 3		93 9		88 2		60 9		45 3	30 4	14 6	3 8	0 5
	II	93 8		95 2		95 1		77 4		43 9		5 7	1 8	4 1	2 2	2 3
	III	96 8		95 8		94 6		76 2		57 3		48 9	30 8	13 4	3 7	1 6
2-4 hrs	I	97 3		90 3		78 2		63 7		55 8		54 2	39 7	19 3	10 2	6 3
	II	95 5		83 6		76 3		75 7		61 8		48 9	36 0	20 5	6 0	2 4
	III	96 1		72 9		54 3		46 8		46 4		38 9	20 6	16 3	4 0	1 0
$1\frac{1}{2}$ - $3\frac{1}{2}$ hrs	I															
	II															
	III	94 2		52 2		26 2		12 9		11 6		10 3	10 3	10 3	5 3	9 4
1-3 hrs	I	96 0	80 6	51 0	25 2	12 4	11 3		13 0		8 0					
	II	91 2	73 3	44 4	20 9	23 0	13 5	16 8	9 6	13 7	11 2					
	III	93 3	76 0	25 1	18 6	10 9	14 9		9 5	7 8	7 3					
0 2 hrs	I	95 3	85 1	72 7	31 6	20 8	14 2	5 8	2 5	1 9	2 9					
	II	94 4	81 4	49 7	29 7	16 2	9 4	7 6	4 7	4 5	5 2					
	III	97 0	80 2	64 6	38 0	15 6	7 0	3 4								

\*From fertilization

**Criterion of Effect**—After irradiation all samples, including the controls, were put away in moist chambers and kept at room temperature, from 21 to 25° C. In from 20 to 30 hours the eggs began to hatch, the larvæ breaking through and crawling away from the egg cases. Those eggs which received sufficient radiation did not hatch. Hatching as an end-point provided a definite criterion of effect, and the relative numbers of hatched and unhatched eggs gave an index of the effect produced by the radiation.

## RESULTS

After performing a number of exploratory experiments in order to find the range of sensitivity at different ages, three complete experiments were carried out, the data for which are shown in Table I. Upon examination of the data, it becomes apparent that the younger eggs are in general more

sensitive and that there are some fluctuating changes. The results for the different experiments have been plotted graphically in Figures 1, 2, and 3, respectively, survival curves being drawn in each case for eggs of different ages.<sup>2</sup> In order to interpret the results more easily summary curves were plotted where possible. Figure 4 gives such curves for eggs of the ages 0-2, 1-3, 4-6, and 5-7 hours. Between the ages of from 2 to 4 and 3 to 5 hours some rather sharp changes in radiosensitivity occur. Accordingly, curves for eggs from 2 to 4 and from 3 to 5 hours of age show considerable variation among themselves, although their general trend in each case is the same. They have been plotted together for the respective ages (Figs 5 and 6).

<sup>2</sup>It will be seen from Table I that the fertility of the controls in each case ranged from 92 to 98 per cent. The general average for each experiment was 96.5, 93.2, and 95.4 per cent, respectively. These values were made to read 100 per cent in plotting the curves, and all of the values for the other points were adjusted accordingly.

By referring to the various graphs the susceptibility changes may be followed qualitatively. For the youngest eggs (0-2 hours old) an asymmetrical sigmoid type of curve

fore much more resistant, the whole curve is higher than it otherwise would be, the lower part being raised more than the upper by this factor. This will account for the sec-

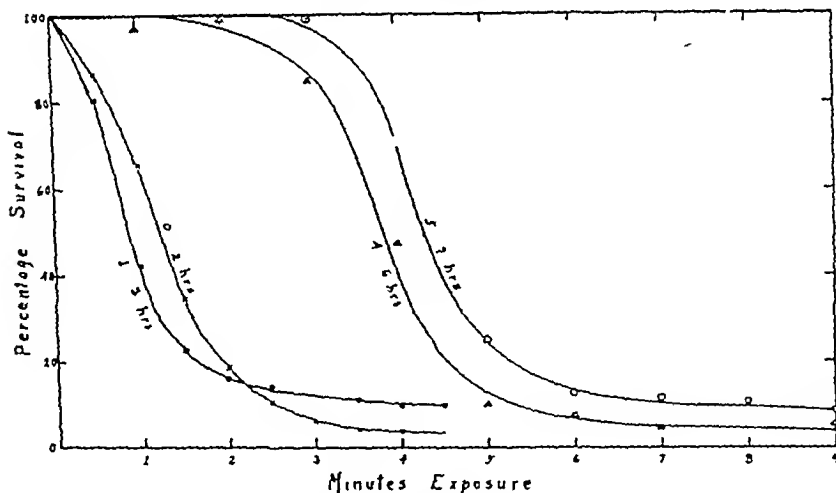
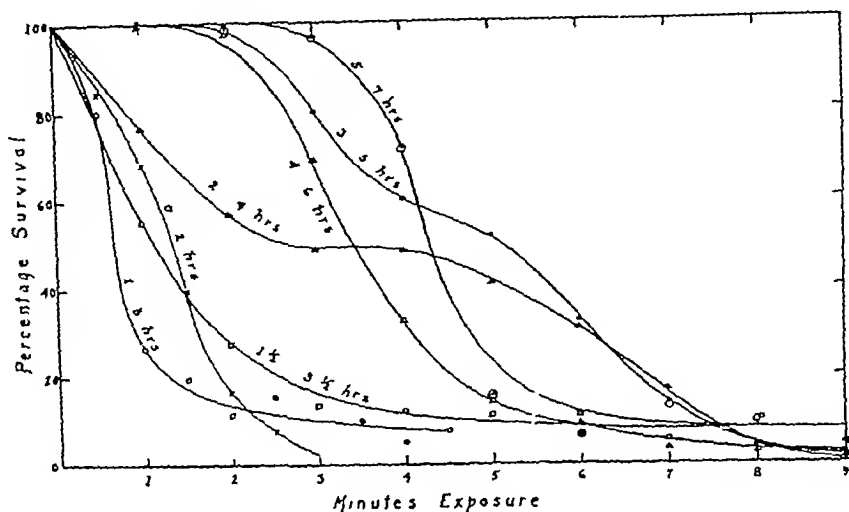


Fig 3 Survival curves for eggs of different ages Exp III

Fig 4 Composite survival curves for Exp I, II, and III

is obtained when percentage survival is plotted against dosage (see Fig 4). One hour later a similar curve is obtained, the main portion of which lies to the left of the first. This indicates that at this stage the eggs were more susceptible to the radiation than they were one hour previous. Since there must be a few older eggs in each sample which are like those just older and there-

fore much more resistant, the whole curve is higher than it otherwise would be, the lower end

Eggs from 2 to 4 hours old were much more resistant than those slightly younger. In order for this condition to exist, it is obvious that an abrupt increase in resistance must have taken place between the ages of from 1 to 3 and 2 to 4 hours. Figure 5 shows the curves for the 2 to 4 hour mate-

rial plotted together. It is significant that some of the eggs of this age are more resistant than any of those just younger or just older. This shows that the sudden increase in resistance is followed by a decrease

younger. Accordingly, the ones slightly older and younger, though different in age, would have the same radiosensitivity. Such a condition would affect the curves by producing a level part somewhere in the mid-

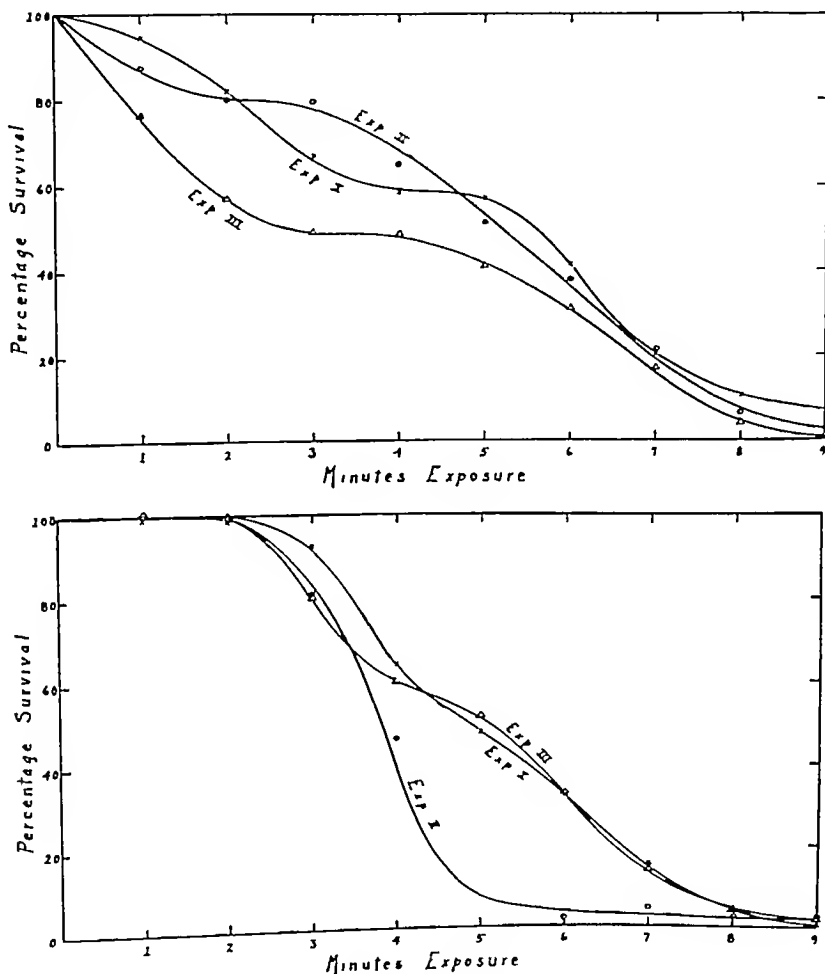


Fig 5 Survival curves for eggs from 2 to 4 hours of age, Exp I II and III

Fig 6 Survival curves for eggs from 3 to 5 hours of age, Exp I II and III

With changes of this sort going on at this stage, it is not surprising that the curves in Figure 5 vary. Despite the variation shown, however, they are generally similar in shape and have particular points of resemblance. For instance, it has just been pointed out that some of the eggs are more resistant than those somewhat older or

middle region. As seen, each curve contains a short level part.

Similar correlations can be made for 3-to-5-hour samples. The curve in Figure 6 marked by small triangles, is interesting (see Fig 3, the group of curves from which it was taken). The lower portion follows the course of the curve for eggs from 2 to

4 hours old, while the upper portion follows the course of the curve for eggs from 4 to 6 hours old. Half of the eggs, therefore appear to be like those of the older group while the other half appear similar to those

Thus it is seen that the changes in resistance at the various stages can be followed, but the process is tedious. It is desirable therefore, to obtain a sensitivity-time curve which will show the changes. For this, it is

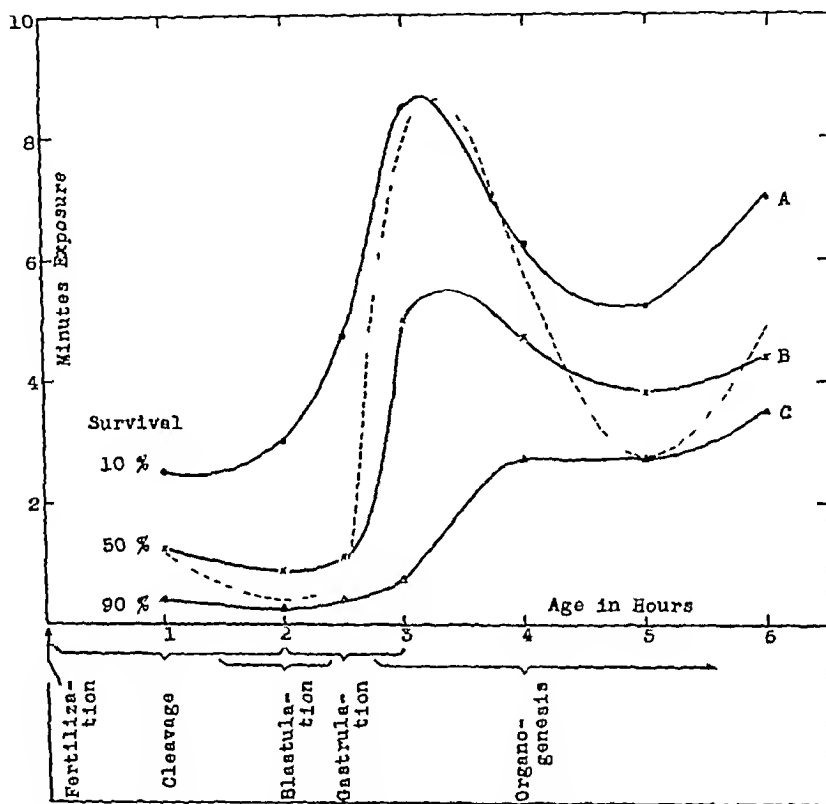


Fig 7 Sensitivity-time curves, showing changes in radiosensitivity for different degrees of irradiation effect

of the younger group. This indicates that the change from the condition at 2 to 4 hours to that at 4 to 6 hours takes place very rapidly. The curve marked with circles is entirely like that for the 4-to-6-hour-old material. The curves for eggs from 4 to 6 and 5 to 7 hours old bear a close resemblance. The eggs of these groups are not only less resistant than some of those from 2 to 4 and 3 to 5 hours old, but show a more uniform susceptibility as is evidenced by the vertical portion of the curves. Practically all are killed when a certain threshold of radiation is reached.

necessary to plot the amount of radiation required to produce a certain effect as a function of age. Any percentage mortality may be used for the effect to be considered. Because it gives the susceptibility of the greatest number of eggs, 50 per cent killing was selected. A set of values has been read from the curves in Figures 4, 5, and 6 and plotted as shown (Curve B, Fig 7). The curve shows in a general way what was described qualitatively above, however the following question may be asked. Will the curve vary depending upon the effect chosen? To answer this—curves for 10 and 90 per cent

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killing (90 and 10 per cent survival, respectively) were plotted. Curves *A* and *C* (Fig 7) were thus obtained. Curve *A* (10 per cent survival) shows the radiosensitivity of the more resistant eggs, while Curve *C* (90 per cent survival) shows it for the more sensitive eggs. Since the values for the sensitivity-time curves were taken from survival curves for eggs which varied as much as 2 hours at least in age and since it has been shown that the radiosensitivity varies markedly with age, it is clear that the eggs must have undergone changes in susceptibility, indicated roughly by the extremes shown in Curves *A* and *C*. The dotted line curve joins the extremes.

Whether the changes in susceptibility are as marked as indicated by the dotted line curve makes little difference, however, for the present consideration, Curves *A*, *B* and *C* are all similar in shape and each shows changes amounting to several hundred per cent, which answers the point in question. The amount indicated by any curve could be reduced by half and still show that important changes in radiosensitivity occur during early development.

#### CORRELATION OF CHANGES IN RADIOSENSITIVITY WITH STAGES IN DEVELOPMENT

In order to correlate the stages in development with the various degrees of radiosensitivity observed, it was necessary to determine what stage the majority of eggs were in at each of the various ages. For this purpose, around 200 untreated eggs of each age were fixed and sectioned. These were examined with two points in mind, in addition to that of associating the age and stage in development: (1) To ascertain what the nature of the developmental activity was at the different stages, and (2) to determine the distribution of stages in each sample, thus checking the uniformity of age.

*Early Development*—Plates I and II show photomicrographs of *Drosophila* eggs

at various stages in development. Typical of insect eggs in general, the *Drosophila* egg consists of a cell wall or vitelline membrane, within which are the single large nucleus and many nutritive granules suspended in a semi-fluid protoplasm (Plate I, 1). Surrounding the egg is an egg case, or chorion, which is secreted by the ovarian cells of the adult female fly. As the eggs pass through the vagina they are capable of being fertilized by spermatozoa which have been stored by the male in the seminal receptacle. Sperm enters the egg through the micropyle of the chorion, and a sperm-nucleus unites with the egg-nucleus to form the segmentation-nucleus.

The segmentation-nucleus, lying free among the yolk granules, is surrounded by a small volume of ooplasm and gives rise to other nuclei by mitosis. Nuclei only are involved in the early cleavages, cell membranes not being present. At the 256-cell stage (eighth cleavage) (Huettnier, 3) the nuclei begin to migrate to the periphery where cell membranes are formed around them and where they arrange themselves into a single cellular layer to form the blastoderm (Plate I, 2-4). At this stage the germ cells are distinguishable by their larger size, located in the posterior polar region. The blastoderm becomes thickened by continued mitosis and growth (Plates I and II, 5-15), and presently gastrulation begins by invagination (Plate II, 16). From this point organogenesis proceeds by differentiation and structural expression.

*Age Distribution in Samples*—The distribution of developmental stages in the different age samples was determined by preparing a chart. Easily recognizable stages were selected and the number appearing in each age sample was counted (see Table II). The stages selected were as follows: (1) A uniform distribution of yolk material throughout the interior of the egg, this stage including all prior to migration of the nuclei to the periphery (Plate I, 1), (2) a

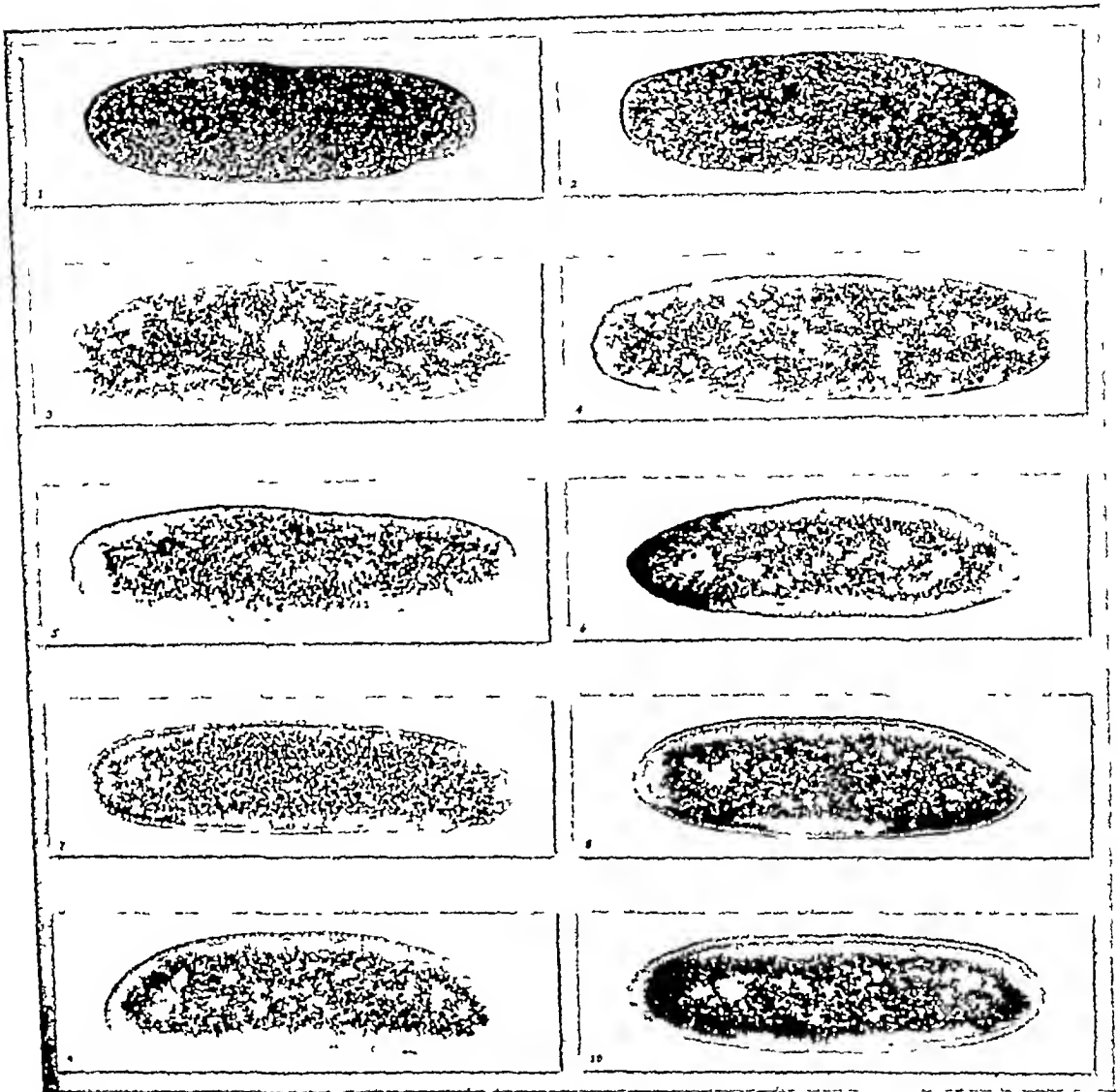


Plate I—Photomicrographs of *Drosophila* embryos in various stages of development ( $\times 75$ ), arranged to show developmental stages only

shallow peripheral area devoid of yolk granules (Plate I 2-6), (3) a thin but definite blastoderm (Plates I and II 7-14), (4) a thickened blastoderm but no gastrulation (Plate II, 15) and (5) gastrulation and beyond (Plate II 16-20)

With the aid of Table II the following information may be derived (1) In each sample there were a few eggs which did not undergo development (2) in each sample

there were a few which were in advanced stages of development these probably being eggs which had been retained in the female fly for a period after fertilization, (3) certain stages were longer than others with respect to time (made evident by the fact that fewer organisms of a given age were in a certain stage than in a stage just younger or just older Stage 2 of eggs 0 20-2 20 hours old is an example of this) and

TABLE II

Age of Eggs in Hours	Developmental Stages*										Total No of Eggs Examined
	1		2		3		4		5		
	No	%	No	%	No	%	No	%	No	%	
0 - 2	105	97.3	1	0.9					2	1.8	108
0 20-2 20	98	80.3	7	5.7	15	12.3			2	1.6	122
1 - 3	63	34.0	18	9.7	78	42.2	5	2.7	21	11.4	185
2 - 4	5	4.2	4	3.3	51	43.0	12	10.2	46	39.0	118
3 - 5	2	3.9			10	19.6	7	13.7	32	62.7	51
4 - 6	6	4.5							126	95.2	132
5 - 7	2	1.5							133	98.5	135

\*See text

(4) the point of most importance here—the majority of the eggs in each age sample tend to fall into one stage or closely associated stages, thus making it certain that most of the eggs in each sample were approximately of the same age

Unfortunately, the chart does not make clear whether the eggs were fertilized at a uniform rate during the entire collecting period, or whether the majority were fertilized during the first or last part of the period. Because of the probability that such variation may often take place, the middle of the collection period taken as the average time of fertilization for a collection of eggs, must be considered as an approximation.

Since the stages in development for the different ages are shown in Table II and since the changes in radiosensitivity and age have been correlated above, the correlation of radiosensitivity and stage in development are obtained by properly locating the stages in development on the time axis of the sensitivity-time curve. This has been done in Figure 7. The sensitivity-time curve as far as it has been determined shows two important parts with respect to radiosensitivity—

first, the comparatively flat portion at the beginning, which shows a low resistance and second the vertical portion, which shows a sudden increase and peak in resistance.

#### DISCUSSION

Having found that the susceptibility of *Drosophila* eggs to x-rays changes markedly during early development it is clear that such changes should be taken into consideration when this material is used in irradiation experiments. Packard (4) in numerous reports and particularly in a recent communication has shown that *Drosophila* eggs are remarkably constant in their response to radiation pointing out that 180 r invariably kill close to 50 per cent of the eggs in a sample.

It is difficult at first to reconcile Packard's results with those presented here. After careful consideration of his experimental procedure however we find that he is very cautious about keeping the age of material precisely the same for all experiments. He collects eggs from actively laying flies during a two-hour period begins the exposure

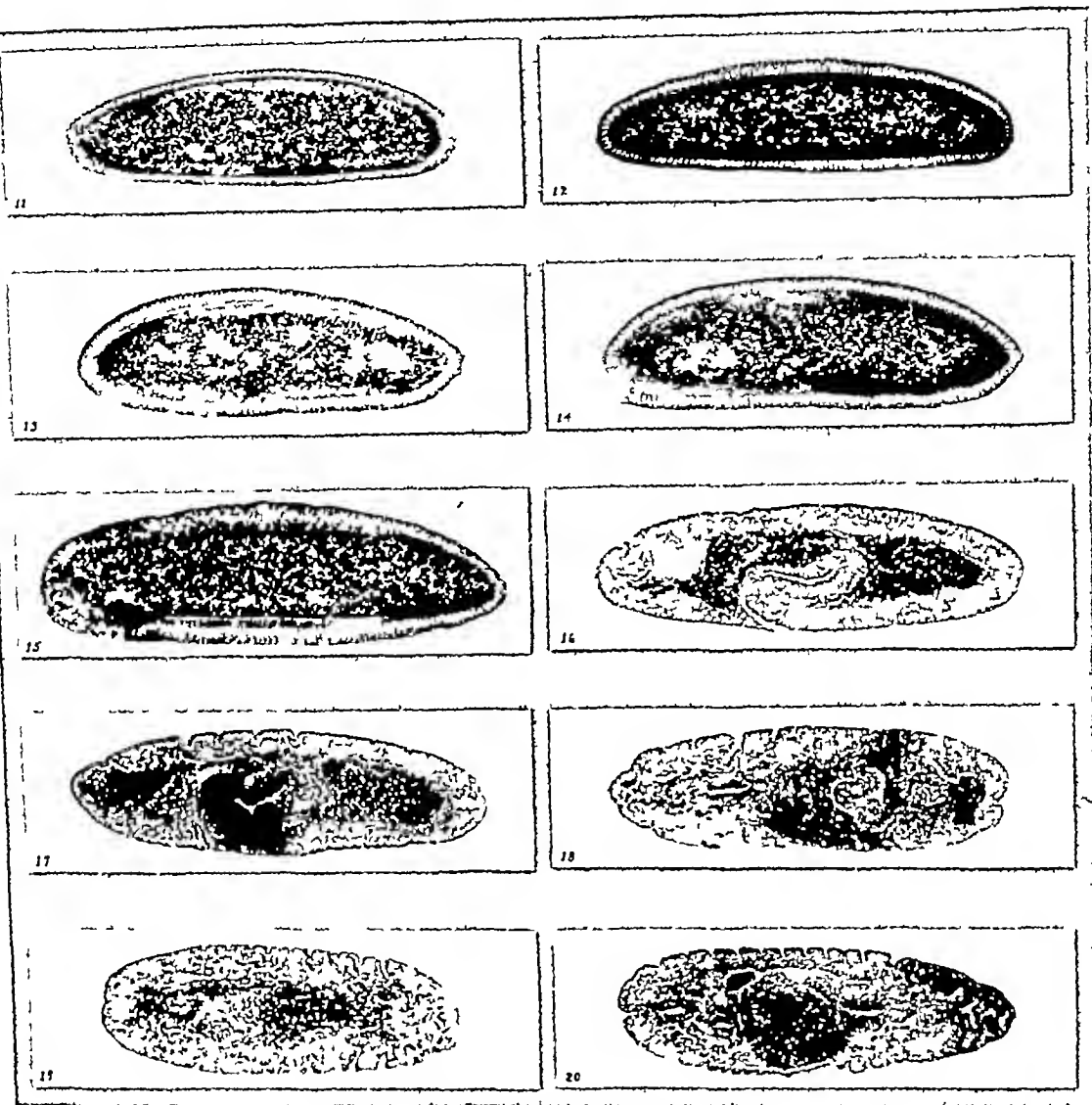


Plate II—Continuation of Plate I (See text)

one hour after the end of the collection period and limits the longest exposure to 25 minutes. In the recent article he states that it is important that these intervals should not vary. Quoting from Packard: "At the time of irradiation that is three hours after the laying period commences, the eggs are in the most sensitive condition. As they grow older they become more and more resistant to the radiations, so that three hours later they are approximately half as sensi-

tive." By comparing these statements with our results as shown in Figure 7, they will be found to be in good agreement. The peak in resistance however which is reached between three and six hours after the laying period commences has not been mentioned by Packard. Since the sensitivity-time curve indicates that extensive changes in susceptibility take place at this time and since the age of material used by Packard falls at the beginning of this period it is plainly evident



why it is necessary to so rigidly control the age factor. That the samples of material used by him contained some of the more resistant eggs is made evident by the shape of his "standard" survival curve. An examination of this shows that, relatively, much more radiation is required to kill the last few eggs in each case.

But, does the precise control of the time relations in experimental procedure fully regulate the age of the material? Since it is age in development rather than age in minutes which designates the susceptibility, it is clear that all factors influencing the rate of development should also be controlled. Temperature, as an example, is particularly important in this respect because the rate of growth and development are dependent on this factor.

In a series of experiments in which we have irradiated two parts of the same collection of eggs at the same time in the same beam of radiation, practically identical results were obtained in nearly all cases. On the other hand, the experiments presented above are good examples of what has been our experience when different samples of eggs were irradiated on different days and an attempt made to keep the conditions of irradiation precisely the same. Take, for instance, the curves marked 1-3 hours in Figures 1, 2, and 3, which are for the same age of material as that used by Packard. The results, though quite consistent for individual experiments, vary for different experiments. In Figure 2 the curve indicates that around 250 r were required to kill 50 per cent of the eggs, while in Figure 3 it shows that somewhat less than 200 r were required to kill the same amount. The relationships of certain curves in each figure indicate reasons for believing that the sets of samples for each experiment, though of the same "clock age" in each case, were not of the same age developmentally. For example, those used for Experiment 2 were all prob-

ably a little more advanced in development than those used for Experiment 3, since the curve marked 3-5 hours is entirely like the one just older, while in Figure 3 the main portion of the curve is like the one for eggs just younger. The degree of separation of curves marked 0-2 and 1-3 hours in each case also gives an index of age. This too corroborates the idea that the material used for Experiment 2 was more advanced than that used in Experiment 3. Packard's method is to average the results for several experiments together, thus obtaining a fairer idea of the effects of the rays. This has a tendency to eliminate the inequalities occurring in different experiments and his work shows well the reproducibility of results which can be obtained when this procedure is followed and when the experiments are carried out in the same way by the same individual. As for experiments performed by different individuals in different laboratories, it seems unlikely that the results can be reliably compared, in view of the fact that the susceptibility changes so rapidly during development and that the rate of development is difficult to control.

It should be clear that our results are not at variance with Packard's. We merely go further in pointing out precautions which must be taken when *Drosophila* eggs are used as test material.

#### CONCLUSIONS

- 1 The radiosensitivity of *Drosophila melanogaster* eggs has been found to vary considerably during early development.

- 2 A correlation of the changes in radiosensitivity with stages in development showed that the eggs become more sensitive during cleavage and blastulation, much more resistant at the time of gastrulation, and more sensitive again following gastrulation, all of this taking place within three hours after the eggs are collected.

*Acknowledgments*—The authors wish to express their appreciation to Dr G Failla and Mrs E H Quimby for valuable suggestions and helpful criticisms and to Miss D S Francis for valuable assistance

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## ATELECTASIS AS A COMPLICATION OF PULMONARY TUBERCULOSIS<sup>1</sup>

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**A**TELECTASIS as a complication of pulmonary tuberculosis has been recognized only during the past few years. It was first called to our attention in post-operative cases by the roentgenologists and surgeons. In these post-operative cases re-expansion or aeration of the atelectatic lung usually occurs promptly, especially if the patient is rolled backward and forward after the method described by Sante (1). In chronic pulmonary infections, especially tuberculosis, the tendency of atelectasis is to remain permanent, with the consequent formation of a fibrotic lung. Packard (2), in 1928, was one of the first to describe atelectasis in pulmonary tuberculosis, remarking on the mildness of the symptoms produced, its permanency, and the beneficial effect it had on the course of the disease. Hablitzon (3) the same year described a case of massive collapse of the left lower lobe in which artificial pneumothorax was employed with improvement. Jacobæus and Westermark (4) reported four cases in tuberculosis and showed the value of artificial pneumothorax in the treatment of these cases. Hennell (5) described it as a factor in the production of fibroid phthisis. Korol (6) reports six cases occurring in tuberculosis. Glenn (7) described a number of cases and showed the value of artificial pneumothorax in the treatment. The writer (8) has reported eight cases and also undertaken to show the

value of some form of artificial compression.

As the complication is rarely fatal, a great deal cannot be definitely said as to what is the exact causative factor in the production of atelectasis in tuberculosis. Undoubtedly the chief causes of bronchial obstruction are aspiration of a caseous plug, hemorrhage with clot formation, plugging of a bronchus with thick tenacious sputum, pressure from an enlarged lymph node, and possibly contraction of a cicatrix.

Lloyd (9) studied a number of cases by means of the bronchoscope, but was unable to find any obstruction in the larger bronchi, and believed that it was in the smaller bronchi beyond the vision of the bronchoscope. Glenn remarked that in all the cases that came under his observation, one or more cavities were present in the upper lobe of the involved side. This was also true in the cases seen by us. In our series the left side was involved more than the right.

The pathology of this complication has been discussed rather extensively. As it does not prove fatal at the time, we must rely on roentgenographic studies and the use of artificial pneumothorax to demonstrate the nature of this condition in tuberculous cases. The pathology is essentially a bronchial or bronchiole obstruction with absorption of the air and a consequent atelectasis or collapse of the air cells in that portion of the lung beyond the obstruction. As a result, the lung volume is reduced to a great

<sup>1</sup>Read before the Radiological Society of North America at the Sixty-Ninth Annual Meeting at St. Louis, Nov. 30, Dec. 4, 1933.



Fig 1 Case 1, Dec. 11 1929  
Multiple large cavities throughout  
the left lung, some infiltration in  
the right apex

Fig 2 Case 1, July 18, 1930  
Results of phrenic exeresis on the  
left also partial atelectasis in  
lower lobe Cavities still present

Fig 3 Case 1, Jan 20, 1931  
Complete atelectasis of left lung,  
with closure of cavities Note  
high position of diaphragm

extent, and a marked negative pressure produced, increasing the already negative pressure in the pleural cavity

Because of this marked negative pressure, the trachea, mediastinum, heart, and diaphragm are forced toward the affected lung in an effort to equalize the pressure. In tuberculosis, as has been stated, atelectasis tends to remain permanent and consequently the lung becomes fibrotic. The contraction of this scar tissue further increases the negative pressure, and is undoubtedly a factor in helping to produce deformity of the chest wall, and even of the spine. In only one of our cases did re-expansion of the lung occur, and this took place in about two weeks, with a fatal result.

Glenn considers the development in massive cases to be slow and gradual, as the obstruction is only partial at first. In those under our care it appeared to develop suddenly. In some there had apparently been at first a partial atelectasis, or one of lesser extent, which persisted for some time without change, whereupon, suddenly, a massive atelectasis would occur. It appears to us that atelectasis may develop successively and suddenly, rather than progressively and slowly.

The tendency of a massive atelectasis is to collapse cavities as well as lung tissue, and in many cases, therefore, it produces a beneficial result on the course of the disease. This apparently does not hold true in cases in which the cavities have a thick wall or are situated in an apex. As a rule, apical cavities are held open by pleural adhesions. Under these conditions cavities tend to enlarge due to the increased negative pressure and the disease is not controlled until they are closed by some artificial means. In addition hemorrhage may occur in these cavities, and also as in one of our cases previously reported a spontaneous pneumothorax may develop. The effect of atelectasis on the opposite lung is to produce emphysema which may in turn have a detrimental effect on disease there present.

One condition that may be mistaken for an atelectasis from the roentgenographic standpoint occurs in artificial pneumothorax cases in which the lung has become fibrotic and fails to re-expand when the compression is discontinued. Here the air in the pleural cavity is absorbed with a marked negative pressure resulting and a consequent phenomenon is produced identical with atelectasis.

Packard, as well as others, has found the symptoms produced by a massive atelectasis relatively mild. In most of the cases seen by us the regular history and even close questioning failed to elicit the time of its

ward the atelectatic lung, and the diaphragm is elevated. There is also usually narrowing of the interspaces, and often the opposite lung may be displaced into the field of the atelectatic lung. In some cases a scoliosis



Fig 4 Case 2, Nov 13, 1931. Massive atelectasis of left lung with resultant fibrosis and marked displacement of heart, trachea and right pulmonary artery. Scoliosis of spine to right. Disease arrested.

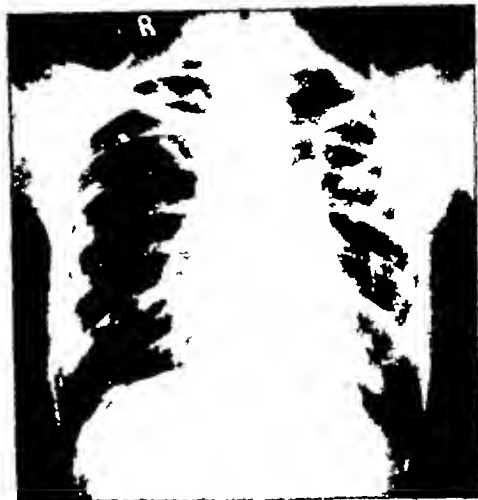


Fig 5 Case 3, Aug 25, 1930. Cavity in left apex, and scattered infiltration.

occurrence. In the cases that developed under our direct supervision, the patients complained of slight pain over the involved lung, and moderate shortness of breath. Some cyanosis and elevation of temperature occurred. In a few, the onset was stormy and at first mistaken for pneumonia.

Physical examination often reveals the true condition in cases in which the atelectasis has been rather extensive. The findings are mainly diminished expansion over the involved side, with cardiac displacement toward the atelectatic lung. The percussion note is dull, and the breath sounds and rales usually disappear. These signs vary, however, at times.

The roentgenogram is the best method of detecting atelectasis. Here, as has been described by others, there is a marked opacity over the involved lobe or lobes, the heart, mediastinum, and trachea are displaced to-

ward the atelectatic lung, and the diaphragm is elevated. There is also usually narrowing of the interspaces, and often the opposite lung may be displaced into the field of the atelectatic lung. In some cases a scoliosis of the spine may result from contraction of the interspaces and a consequent bowing of the spine toward the opposite direction. This may be corrected by pneumothorax. When the atelectasis is of lesser degree, the roentgenogram or fluoroscope is probably the only means of detecting it.

The treatment of atelectasis developing in pulmonary tuberculosis depends upon the closure of cavities in the involved lung. In the cases in which the desired effect is obtained by this complication alone, interference in any way is certainly not indicated. In a few of our cases, and in cases reported by Packard and Hennell, decidedly beneficial effects were obtained. The marked displacement of the heart, mediastinum, and diaphragm apparently causes no discomfort to the patient, and the disease may become entirely arrested.

In cases in which cavities do not close the tendency is for them to enlarge due to the increase of negative pressure, consequently

there is a progression of the disease. In these instances pneumothorax, or some form of artificial compression, is the treatment of choice. The intrapleural pressure is greatly reduced, and many times the fluid

ly develops when the air in the pleural cavity is absorbed in these cases, and with the absorption of fluid, the displacement of mediastinum, heart, diaphragm, and trachea re-occurs.



Fig 6 Case 3, May 14, 1931. Massive atelectasis of left lung.

in the manometer is sucked over the top so that the exact reading cannot be obtained. In nearly all the cases previously reported by us, pneumothorax was attempted, and excellent results obtained. The heart, mediastinum, trachea, and diaphragm were returned to their normal positions, the intrapleural pressure increased to or approximately normal, and clinical improvement followed. At times, pneumolysis is necessary for complete closure of cavities. In cases in which an adherent pleura is present and pneumothorax cannot be instituted we have employed phrenic exeresis and thoracoplasty with most beneficial results.

In two of our cases in which pneumothorax was instituted, it was discontinued, but then only because of the desire of the patients. A phrenic exeresis was done however before discontinuance. Re-expansion of the lung did not occur. Fluid usual-

#### CASE REPORTS

Case 1. A M.,<sup>2</sup> male, aged 36. Onset of tuberculosis in December, 1926. Sputum positive. Under rest treatment condition became gradually worse. Weight fell from 180 to 121 pounds. Patient ran an afternoon temperature and raised about four ounces of sputum per day. Physical examination on Dec 8, 1929, showed *Right chest*, resonance fair, medium rales in upper portion, *left chest*, medium coarse rales, base up, increased whispered voice in upper.

Roentgenogram (Fig 1), Dec 11, 1929, showed a fibrocaseous infiltration in the right upper, with a questionable cavity. The left lung showed large cavities scattered from apex to base. Under rest, patient showed no improvement, so a left phrenic exeresis was done April 24, 1930, resulting in moderate rise of the diaphragm. Roentgenogram (Fig 2) taken July 18, 1930, showed the left diaphragm high, cavities on the left somewhat smaller, but still open, some opacity in left base, possibly an area of atelectasis.

Following this there was a slow gain in weight. In October, 1930, weight was 140 pounds, a gain of about 20 pounds. Patient was on continuous bed rest, and under daily observation there was no material change in the lung. On Oct 15, 1930 he had a moderate hemorrhage. At this time was under treatment in Los Angeles. Following the hemorrhage, his temperature was elevated and he stated that he had some pain in the left lung. However he soon began to improve and gain weight.

Chest examination following the hemorrhage showed dullness over entire left lung with marked increase in whispered voice and bronchial type of breathing. There were a few rales over the left lung and in the right apex. Roentgenogram (Fig 3) taken Jan 20, 1931,

<sup>2</sup>Case previously reported.

showed the pathology in the right apex decreased considerably, no cavity being visible. The left lung was opaque and the diaphragm extremely high. The heart was displaced to the left. The cavities had now disappeared. Under further rest treatment the patient continued to gain in weight, and sputum was reduced. At present the weight is 181, a gain of 41 pounds since the atelectasis. Patient is now able to be up and about, and hopes to return to work shortly. Undoubtedly the massive atelectasis developed at the time of the hemorrhage, in October, 1930. There probably was a partial atelectasis, however, as seen in the last roentgenogram prior to the hemorrhage.

This case shows well the beneficial effects of atelectasis which, in this instance, resulted in closure of cavities and an apparent arrest of the disease.

Case 2 A. R.,<sup>3</sup> male, aged 45. Developed tuberculosis in 1914. Was quite ill in 1917 and was told he had pneumonia. Rested 27 months and improved steadily. In 1919 he was able to return to work and has felt well up to the present time, except for an occasional pain in the left chest.

Examination May 28, 1930, showed retraction of left chest, with diminished expansion. The apex beat was displaced to the left. The left lung was dull and the breath sounds absent in base and amphoric in apex. There were a few dry crackles posteriorly on the left. Marked spinal curvature to right. Weight 150 (normal 150). Sputum negative.

Roentgenogram (Fig 4) dated Nov 13, 1931, showed a massive atelectasis of the left lung with a marked displacement of the heart and trachea. Diaphragm was high but not well visualized. There was a decided scoliosis of the spine to the right. This latter was due to the contraction of the fibrotic left lung, with narrowing of the interspaces and a resultant bowing of the spine.

In this case the atelectasis undoubtedly occurred in 1917 at the time he was told he had pneumonia. Marked clinical improvement with an arrest of the disease is also demonstrated in this case.

Case 3 C. J., female, aged 42. Developed tuberculosis in Summer of 1930. Had a severe cough, with weakness and loss of weight. Sputum was positive in August, 1930. Rested at home and showed improvement, gaining weight, and temperature remained normal.

Roentgenogram (Fig 5), taken Aug 25, 1930, showed heart, trachea, and diaphragm in normal positions, with some infiltration in the right apex. In the left there was scattered infiltration throughout, with a small cavity behind the second interspace.

Examination in December, 1930, showed a few medium rales in the right apex. On the left there was slight impairment of resonance, with medium coarse rales in upper part of chest. Breath sounds were slightly diminished.

Roentgenogram taken Dec 12, 1930, showed some fibrous infiltration in the right apex. The left lung field was slightly narrowed and hazy. In the upper part of the left lung there was a caseo-ulcerative infiltration. Scattered throughout the lower portion of the left lung were numerous small areas of caseous pneumonia. The base of the heart was displaced slightly to the left. The left diaphragm was depressed. It is possible that there were areas of atelectasis in the upper part of the left lung at this time, along with the other pathology. The cardiac displacement and slight haziness would indicate this.

Patient showed only slight improvement and on April 26, 1931, developed pain in the left chest, and high temperature. Her cough increased and she noticed some shortness of breath, and mild cyanosis of nails. Examination of the chest on April 29, 1931, revealed dullness over the left chest, with diminished breath sounds in the base. Whispered pectoriloquy was present in the apex. Position of heart is not recorded. The elevation of temperature continued for about two weeks, and the cough improved somewhat. Patient began to feel better, but ran an afternoon temperature.

Roentgenogram (Fig 6) taken May 14, 1931, showed a massive atelectasis of the left lung with some areas in the apex suggesting cavities. The heart was displaced to the left and the diaphragm was high. The right apex

<sup>3</sup>Reported by courtesy of J. C. Holmes, M.D.

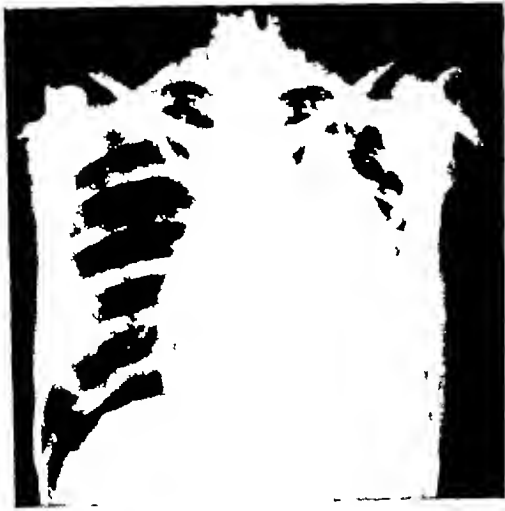


Fig 7 Case 3, May 17, 1931 Effect of pneumothorax, with a return of mediastinum, diaphragm, etc., to normal position. Cavity held open by apical adhesions

appeared improved. Physical examination revealed condition about the same as on April 29.

On May 15, 1931, artificial pneumothorax was instituted. The initial reading could not be obtained because of the marked negative pressure. After 350 c.c. of air were given, the resultant pressure was  $-9$   $-5$ . Since then, the patient has continued under pneumothorax and has improved considerably, but she still has slight temperature, some cough, and the sputum remains positive.

Roentgenogram (Fig 7) taken May 17, 1931, shows a fair compression of the left lung. Cavity in apex of compressed lung, however, is held open by adhesions. The heart has returned to its normal position, and the diaphragm is down. There is some fluid present in the pleural space; a left phrenic eversion was done Aug 22, 1931, with only a fair rise in the diaphragm. At the present time the cavity is still open and will probably require pneumolysis to effect its closure. Patient has periodic upsets of temperature and sputum is positive.

Case 4 A O,<sup>4</sup> female, aged 45. Developed tuberculosis in May, 1929. Lost about 25 pounds and had intermittent attacks of pleu-

ris in the right lung. In July, 1930, she had a small hemorrhage and since then has been running an afternoon temperature.

Examination Nov 4, 1930, showed. In right chest diminished expansion and medium rales, base up. Percussion note was fairly resonant and no cavity signs were made out. In the anterior mid-portion of the left lung there were a few medium rales. Weight, 106 (normal, 145).

Roentgenogram (Fig 8) taken Nov 5, 1930, showed scattered fibrous infiltration in right upper, with a suspicious area of cavitation. The right diaphragm was slightly elevated, and there was an opaque area in the base near the heart, the heart being slightly displaced to the right. There was some diffuse caseous infiltration in the mid-portion of the left lung. Under the fluoroscope there was slight restriction of motion of the right diaphragm. The opaque area in the right base was first thought to be a localized tuberculous pneumonia. However, this remained stationary, and in all probability was an atelectatic area. Under rest, condition improved somewhat, and patient gained 20 pounds in weight, but she continued running a daily temperature.

A roentgenogram taken Jan 12, 1931, now showed a definite cavity in the right apex, also a slight increase in pathology in the left lung. Monthly physical and fluoroscopic examinations were made, and patient was seen daily. On Feb 18, 1931, she complained of some pain in the right chest, with an increase in cough. Temperature rose from 99.5 to 101.0 and pulse from 95 to 115. She did not complain of shortness of breath or palpitation, but slight cyanosis was present. Chest examination now revealed dullness over the right lung, with absence of breath sounds in the lower part. The breath sounds were amphoric in character in the apex. The rales had disappeared, and the heart beat could be felt to the right of the sternum. Fluoroscopic examination on February 18 showed an atelectasis on the right side.

Roentgenogram (Fig 9 over-exposed) taken Feb 20, 1931, showed trachea and heart markedly displaced to the right and the right

<sup>4</sup>Part of this case previously reported



Fig 8 Case 4 Nov 5, 1930  
Cavity in right apex, with atelectatic area in base. Diaphragm shows slight elevation.

Fig 9 Case 4, Feb 20 1931  
Atelectasis of right upper lobe.

Fig 10 Case 4, March 28 1931  
Shows effect of artificial pneumothorax with return of viscera to normal position. Cavity still open in right apex.

diaphragm high. The cavity in the right apex was now well distinguished. The atelectasis was confined chiefly to the upper lobe. The patient did not complain of much discomfort.

Artificial pneumothorax was instituted on Feb 20 1931. The initial manometer reading could not be obtained as the fluid was sucked over the top. Patient was given 375 cc of air, the resultant reading being  $-6-2$ . Under the fluoroscope the heart was seen in its normal position and the diaphragm was depressed. Patient improved somewhat under pneumothorax but still ran a temperature and sputum was positive.

Röntgenogram (Fig 10) taken March 28, 1931 showed a partial pneumothorax, the cavity being held open by adhesions. Heart and diaphragm were seen in normal position. A right phrenic excision was done on May 25, 1931 with the hope that the cavity would close. Röntgenogram (Fig 11) taken on May 16 1931 showed considerable elevation of the diaphragm, cavity however being still present. Patient returned to her home on May 25 1931 but was not able to continue pneumothorax. She soon developed fluid with the absorption of the air and for a while had a stormy time. She returned for examination on Nov 22 1931 when her condition was poor, the weight having dropped to 98 pounds.

Röntgenogram (Fig 12) taken Nov 22

1931, showed a homogeneous opacity over the right lung, with the exception of the apex, where there was a large cavity. The heart and trachea were displaced to the right. The right diaphragm could not be seen. There was a slight curvature of the spine to the right. The interspaces were narrowed slightly. There was a possibility of fluid still being present in the right pleural space. (Tapping will be attempted.) The pathology of the left chest has resolved.

This case is extremely interesting in that it shows successive atelectasis developing, with a return to normal position of the heart, diaphragm, etc., with the use of pneumothorax. In addition, it demonstrates the lack of expansion of an atelectatic lung following the use of artificial pneumothorax, and also it plainly shows enlargement of apical cavities in these cases. Thoracoplasty or a paraffin pack will undoubtedly have to be resorted to in this case when patient's condition will permit.

Case 5. P. D. female aged 26. First seen Aug 13 1929. First noticed symptoms in May 1929, following a cold. Had severe cough with some pain in right lung. Sputum positive. Has been resting 24 hours daily since.

Examination on Aug 13 1931 showed. In right chest diminished expansion in the upper part with diminished resonance. Distant



whispered pectoriloquy in upper part, and a few fine medium rales in mid-portion and coarse rales in upper. Under the fluoroscope, right diaphragm motion slightly restricted. Weight 92 pounds (normal 98)



Fig 11 Case 4, May 16, 1931 Shows rise in diaphragm following phrenic excision cavity not closed

Roentgenogram (Fig 13) Sept 5, 1929, showed base of heart displaced to right and slight elevation of right diaphragm. In the mid-portion of the upper lobe there was a fairly homogeneous density, probably from a localized atelectasis, in which were areas of lesser density. There was some infiltration in the left lung behind the first rib. On Sept 8, 1931, patient had a moderate hemorrhage.

On Sept 10, 1931, pneumothorax was instituted on the right side. The initial manometer reading was  $-10-7$ . Patient was given 200 cc of air, and the reading was  $-5-3$ . Fluoroscopic examination on Sept 13, 1931, showed a partial compression of the upper lobe, heart and mediastinum in normal position. Pneumothorax has been continued.

Roentgenogram (Fig 14) taken Jan 9, 1930, shows a partial collapse of the right lung with adhesions in the apex, the heart in normal position and the diaphragm slightly depressed. A phrenic excision has recently been done with the idea of discontinuing the pneumothorax. Patient has made marked improvement, does not cough, and has no ex-

pectoration. It will be interesting to see if re-expansion will occur when pneumothorax is discontinued.

The area in the right upper lobe would probably be considered a pneumonic area by many, but we believe that it is possibly a partial or localized atelectasis, with some pneumonic infiltration and cavitation. The demonstration of the displaced heart and trachea with the slight elevation of the diaphragm and the marked negative initial pneumothorax readings, strengthen the possibility of an atelectasis. A simple pneumonic infiltration would not as a rule cause displacement of the heart and trachea or elevation of the diaphragm.

Case 6 E N,<sup>5</sup> female, aged 32. Developed tuberculosis in December, 1928, and under rest treatment improved slightly. Had intermittent pain in both sides of the chest. For the past few months has had periodic upsets with chills and high temperature, which would last a few days. She noticed that her sputum was decreased at these times raised about four ounces sputum daily.

Chest examination Oct 14, 1930, revealed a few scattered rales over the right lung. On the left there was dullness base up, and diminished breath sounds. A few crackles were heard over the left lung.

Roentgenogram (Fig 15) taken on Oct 15, 1930 showed opacity of the left lung, in which could be seen a fairly large cavity. The heart was displaced to the left and the diaphragm was high.

Patient's weight was 128 (normal, 130). Sputum was positive. She usually ran a daily temperature and continued having periods when she would run high temperature with reduction of sputum due to blocked drainage. Artificial pneumothorax was attempted a number of times but there was no pleural space free. A left phrenic excision was done Nov 12 1930 resulting in only a slight rise of the diaphragm and there was no further improvement. On June 15 a thoracoplasty was done. Recovery was good. Since then the patient has been greatly improved with a marked reduction in sputum. Temperature has been normal and she is now on exercise.

<sup>5</sup>Part of the case previously reported.



Fig 12 Case 4 Nov 23, 1931 Return of displacement of viscera after discontinuing pneumothorax cavity in apex increased in size

Roentgenogram (Fig 16) taken Sept 22, 1931, shows the result of the thoracoplasty on the left. In this case films taken prior to the atelectasis could not be obtained, and a careful history did not reveal the time of its occurrence.

Case 7 A G, male, aged 30. First seen April 27, 1928. Tuberculosis first diagnosed in 1923. Had severe cough and loss of weight. Treatment consisted chiefly of rest. Had pleurisy at various times on both sides. No history of acute upsets or hemorrhage. Weight 151 (normal 156). Examination showed diminished expansion of the left chest with dullness apex to base. The breath sounds were absent in the base and amphoric in the apex. Few fine medium rales in the apex.

Roentgenogram (Fig 17) taken May 5, 1928, shows a marked opacity over the left lung with heart and trachea displaced into left chest. Diaphragm was high. In the apex there were areas of lesser density suggestive of cavitation. Sputum was positive. Temperature ranged to 100, pulse 95. Patient coughed considerably and expectorated about two ounces daily. Had periodic upsets of temperature and gastric disturbances.



Fig 13 Case 5, Sept. 5, 1929 Triangular atelectatic area in right upper lobe cavities present in opaque area slight cardiac displacement and elevation of the right diaphragm

From pneumothorax, instituted June 6, 1928, the initial reading could not be obtained, due to marked negative pressure. Patient was given 300 c c of air, and the resultant reading was  $-5 -4$ . Heart and trachea returned to normal position, as seen under the fluoroscope.

Roentgenogram (Fig 18) August 24, 1928, shows three-fourths compression of left lung, cavities in apex held open by adhesions, heart in normal position, left diaphragm depressed. Later fluid developed, but the pneumothorax was continued with frequent aspiration until March, 1930. Air pocket decreased in size slowly.

There was marked clinical improvement. Sputum became negative. Pneumothorax was discontinued because of loss of pleural space and difficulty in obtaining reading. Roentgenogram taken Feb 1, 1930, shows heart and trachea displaced to right and diaphragm elevated. There is an area of pneumothorax along the lateral border. The left lung is still opaque.

On May 24, 1930, a left phrenic excision was done and patient has still continued to improve. Weight is now 176, temperature normal, no cough or sputum.

Roentgenogram (Fig 19) taken May 11, 1931, shows the atelectasis of the left lung, with contraction of the interspaces and sco-

whispered pectoriloquy in upper part, and a few fine medium rales in mid-portion and coarse rales in upper. Under the fluoroscope, right diaphragm motion slightly restricted. Weight 92 pounds (normal 98)



Fig 11 Case 4, May 16 1931 Shows rise in diaphragm following phrenic exeresis cavity not closed

Roentgenogram (Fig 13) Sept 5, 1929, showed base of heart displaced to right and slight elevation of right diaphragm. In the mid-portion of the upper lobe there was a fairly homogeneous density, probably from a localized atelectasis, in which were areas of lesser density. There was some infiltration in the left lung behind the first rib. On Sept 8, 1931, patient had a moderate hemorrhage.

On Sept 10, 1931, pneumothorax was instituted on the right side. The initial manometer reading was  $-10$   $-7$ . Patient was given 200 c.c. of air, and the reading was  $-5$   $-3$ . Fluoroscopic examination on Sept 13, 1931, showed a partial compression of the upper lobe, heart and mediastinum in normal position. Pneumothorax has been continued.

Roentgenogram (Fig 14) taken Jan 9, 1930, shows a partial collapse of the right lung, with adhesions in the apex, the heart in normal position and the diaphragm slightly depressed. A phrenic exeresis has recently been done with the idea of discontinuing the pneumothorax. Patient has made marked improvement, does not cough, and has no ex-

pectoration. It will be interesting to see if re-expansion will occur when pneumothorax is discontinued.

The area in the right upper lobe would probably be considered a pneumonic area by many, but we believe that it is possibly a partial or localized atelectasis, with some pneumonic infiltration and cavitation. The demonstration of the displaced heart and trachea, with the slight elevation of the diaphragm and the marked negative initial pneumothorax readings, strengthen the possibility of an atelectasis. A simple pneumonic infiltration would not as a rule cause displacement of the heart and trachea or elevation of the diaphragm.

Case 6 E. N.,<sup>2</sup> female, aged 32. Developed tuberculosis in December, 1928, and under rest treatment improved slightly. Had intermittent pain in both sides of the chest. For the past few months has had periodic upsets, with chills and high temperature, which would last a few days. She noticed that her sputum was decreased at these times, raised about four ounces sputum daily.

Chest examination Oct 14, 1930, revealed a few scattered rales over the right lung. On the left there was dullness, base up, and diminished breath sounds. A few crackles were heard over the left lung.

Roentgenogram (Fig 15) taken on Oct 15, 1930, showed opacity of the left lung, in which could be seen a fairly large cavity. The heart was displaced to the left and the diaphragm was high.

Patient's weight was 128 (normal, 130). Sputum was positive. She usually ran a daily temperature, and continued having periods when she would run high temperature with reduction of sputum, due to blocked drainage. Artificial pneumothorax was attempted a number of times, but there was no pleural space free. A left phrenic exeresis was done Nov 12 1930, resulting in only a slight rise of the diaphragm, and there was no further improvement. On June 15 a thoracoplasty was done, recovery was good. Since then the patient has been greatly improved, with a marked reduction in sputum. Temperature has been normal and she is now on exercise.

<sup>2</sup>Part of this case previously reported



Fig 16 Case 6, Sept 22, 1931 Result of thoracoplasty on the left



Fig 18 Case 7, Aug 24 1928 Results of artificial pneumothorax on the left



Fig 17 Case 7, May 5 1928 Atelectasis of left lung cavity in apex trachea heart, and right pulmonary artery displaced to left



Fig 19 Case 7, May 11, 1931 Shows displacement of viscera with complete absorption of pneumothorax scoliosis to right Case apparently arrested

and on March 7, 1930 died of a massive hemorrhage

This case probably shows a gradual development of a massive atelectasis as described by Glenn (7). Its onset was stormy being first mistaken for pneumonia. Had we been in a position to have taken a roentgenogram at the time of atelectasis we would undoubtedly have found more than the physical signs indicated at first.

Case 9. I. W. male aged 34. Tubercu-

losis first developed in 1924. Under rest treatment, condition did not improve. Some pleurisy at that time on left side, and an occasional small hemorrhage. Physical examination as recorded in October, 1926, showed slight impairment of resonance over left lung breath sounds being slightly diminished in the left lower. In the right upper part of the chest there were medium coarse rales right side



Fig 14 Case 5, Jan 9, 1930 Shows return to normal position of viscera and closure of cavities by artificial pneumothorax



Fig 15 Case 6 Oct 15 1930 Atelectasis left upper lobe, with cavities

liosis of the spine to the right, no cavities are visible

This case also shows the value of artificial pneumothorax, and that re-expansion did not occur with discontinuance of pneumothorax

Case 8 E W, male, aged 29 Tuberculosis first developed in 1926 with right pleurisy, cough, and loss of weight Sputum was positive Patient rested for three years, but had periodic upsets Examination on Nov 2 1929, showed resonance fair over both lungs There were a few medium rales over the right upper portion In the apex of the left lung there was a distant bronchial breathing Over the entire left lung there were medium coarse rales Fluoroscopic examination showed good motion of both diaphragms, with scattered infiltration through the left lung Heart was in normal position

Roentgenogram taken May 29, 1929 showed scattered small calcified areas over the right lung The aortic area was widened In the left apex a cavity was seen and scattered throughout the left were areas of infiltration Amount of sputum in 24 hours was 2 ounces

On Dec 14, 1929 patient developed a cough and temperature rose to  $100^{\circ}$  Examination revealed diminished breath sounds in left base Two days later cavity signs developed in the apex of the left lung and the heart

was found shifted to the left Temperature was  $101^{\circ}$  Cough was harsh and patient became slightly hoarse Some blood was present in sputum A friction rub developed over the precordium Examination made on Dec 30, 1929, showed dullness over the entire back and reaching into the axilla on the left The breath sounds over the entire back were bronchial in character, and there were coarse rales over the anterior chest The heart was markedly displaced to the left Temperature persisted about  $103^{\circ}$  pulse 136

Patient was seen every few days following this, and showed some slight improvement Lung condition remained the same He was moved to the hospital on Jan 14 1930 where a roentgenogram was taken This showed a massive atelectasis of the left lung heart markedly displaced to the left Part of the right lung could be seen to the left of the spine In the left apex was a large cavity diaphragm was not visualized Patient remained in the hospital temperature ranging from  $99^{\circ}$  to  $102^{\circ}$  pulse from 100 to 120 Fluoroscopic examination later showed condition of lung about the same except cavity in left apex was slightly larger diaphragm was elevated Pneumothorax was attempted Feb 7, 1930 but patient fainted and it was not attempted again Patient gained only slightly



Fig 16 Case 6, Sept 22, 1931 Result of thoracoplasty on the left



Fig 18 Case 7, Aug 24 1928 Results of artificial pneumothorax on the left



Fig 17 Case 7 May 5 1928 Atelectasis of left lung cavity in apex trachea heart and right pulmonary artery displaced to left



Fig 19 Case 7 May 11, 1931 Shows displacement of viscera with complete absorption of pneumothorax scoliosis to right Case apparently arrested

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## SUMMARY AND CONCLUSIONS

Atelectasis has in the last few years taken its place as a complication of pulmonary tuberculosis, and offers an explanation of many of the heretofore obscure opacities as seen in the roentgenogram. It undoubtedly is the chief cause of pulmonary fibrosis, either localized or massive, in cases in which there is displacement of the mediastinum, trachea, and heart toward the affected side, or elevation of the diaphragm. Its onset is usually sudden, with few symptoms. It may, however, occur successively in smaller or larger areas and is thought, therefore, to develop gradually. Scoliosis of the spine may be the result of an atelectasis.

Its effect on tuberculosis may be beneficial and cause arrest of the disease in cases in which its effect is opposite, some form of artificial compression of the lung offers the best results. Undoubtedly in cases in which a localized or partial atelectasis exists, with an open cavity, artificial pneumothorax should be instituted before the possible occurrence of a massive atelectasis, with the hope that when the disease becomes arrested and the pneumothorax is discontinued, re-expansion of the compressed lung will result.

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## DISCUSSION

DR HENRY SNURE (Los Angeles, Calif.)  
Dr Gatterdam's theories that the bronchial obstruction in tuberculosis is due to clot-forming hemorrhage, caseous plug, pressure from enlarged lymph glands, plugging by tenacious sputum, and scar formation seem logical in view of what we know about atelectasis following abdominal operations, etc. One author, however, reports seven cases in which bronchoscopic examination was done and no visible plugging of the bronchus was found.

Dr Gatterdam treated nearly all his cases by pneumothorax following the primary atelectasis. It is to be noted that the Koch bacillus has a tendency to encourage fibrous tissue formation, which may account for the fact that in all but one of his cases the collapse was permanent. However, in the removal of bronchial tumors accompanied by collapse for weeks and secondary non-tuberculous infection in the collapsed lung, the latter will re-expand after the obstruction has been removed. Due to fear of spreading the infection, it would, perhaps be unwise to use Sante's method of re-expanding a collapsed lobe in the tuberculous types of atelectasis. The use of the bronchoscope in tuberculous lung infections might also be questioned.

Dr Gatterdam has been fortunate in observing most of his cases in his sanatorium. In a typical case he reports that a routine film was made of a certain patient, and the heart was found to be in its proper position. A few days later the patient had a slight rise in temperature with slight pain. A repeat film showed collapse of the lower left lobe with the heart markedly displaced toward the left axilla. To and fro movement of the heart was noted on the fluoroscopic examination. Apparently these slight reactions to collapse are due to the fact that the patient had been at rest for a long period and small areas of the lobe involved were already in a state of collapse, so that complete collapse caused little





Fig 20 Case 9, Oct 1926 Area of atelectasis in left lung, displacement of heart and diaphragm cavity behind second interspace on the left



Fig 21 Case 9, July, 1931 Shows marked displacement of heart, trachea, and right pulmonary artery, with arrest of disease following a spontaneous pneumothorax which later absorbed Diaphragm not visualized

showed a few medium rales in the apex sputum was positive, and weight was 110

Roentgenogram (Fig 20), in October, 1926, showed heart and trachea displaced to the left, with diaphragm elevated

In the right apex there was slight fibrous infiltration The left lung field was contracted and there were numerous areas of what appeared to be caseous infiltration scattered throughout There was a cavity behind the second rib on the left, and a fairly heavy density in the base The cardiac displacement and the elevated diaphragm indicate an atelectasis and undoubtedly the areas first considered small areas of caseous pneumonia were in reality atelectatic Under rest treatment condition remained about the same Patient was an ideal case for pneumothorax, yet he refused

In September, 1929, he had a severe hemorrhage, and also developed severe pain in left chest, with shortness of breath Percussion note was hyperresonant A diagnosis of spontaneous pneumothorax was made Air and (later) fluid were withdrawn from the left pleural cavity a number of times Patient had rather a stormy time, but soon began to show improvement, which has continued to the present time

Roentgenogram (Fig 21) taken in July, 1931, shows heart extremely displaced into left chest, marked deviation of the trachea, and left diaphragm high The right lung is emphysematous and extends beyond the spine on the left side, the left lung is opaque and contracted, the interspaces on the left are narrowed At the present time patient is symptom-free except for slight dyspnea Sputum is persistently negative and the temperature normal This can be considered an arrested case It demonstrates two things the development of a spontaneous pneumothorax on an atelectasis, and the phenomenon seen in pneumothorax cases in which the lung does not re-expand A displacement similar to that of massive atelectasis occurred, due to the marked negative pressure produced by the absorption of the air contained in the pleura Undoubtedly this lung is now a hard fibrotic mass, the same as seen in an atelectatic lung which does not re-expand

The main difference between these two types is that in atelectasis the air in the lung cells is absorbed producing the marked negative pressure, while in the case of pneumothorax in which the lung has become fibrotic, the air in the pleural cavity is absorbed

reaction. In my work in a general hospital, if I were to see such a case brought in with tuberculous changes in the lungs, I would be inclined to believe that displacement of the heart was due to a fibrosis pulling the heart over, rather than a collapsed lobe. No doubt I have made such mistakes in the past.

Now that atelectasis in tuberculosis has been called to our attention, I am sure that we will all be looking for such a condition in the future and many more cases will be reported.

DR M. L. PINDELL (Los Angeles, Calif.) I am reluctant to discuss Dr. Gatterdam's paper, for I have recognized only a few cases of atelectasis in my work in tuberculosis, and, therefore, feel that I am not qualified.

In 1930, my attention was first called to atelectasis on a large scale in an exhibit made by the University of California, adjoining one I had on tuberculosis. I asked the exhibitor if he could pick out any cases of atelectasis in my exhibit. The result was that he found two which he thought were atelectatic lungs.

I think we should give Dr. Gatterdam a great deal of credit for elaborating on this rather new subject. He has shown many cases, and most of them appear to be proven (the cases that have occurred overnight). Therefore, there is no doubt but that atelectasis occurs more frequently than we have thought, especially partial atelectasis. Perhaps, in many cases of the latter in tuberculosis, the plugging is in the terminal bronchi and for this reason the bronchoscopist has failed to locate the trouble.

It seems good to have a roentgenologist call our attention to this condition. The study of the living is many times more enlightening than the study of the dead. The pathologist has called our attention to collapsed lungs, but his opinion was overwhelmingly in favor of fibrosis and adhesive collapse.

DR B. A. RHINEHART (Little Rock, Ark.) Dr. Gatterdam has told us how some of these cavities grew larger, and how some of them, according to his opinion, grew far down. It seems to me that the enlargement of the cavities is probably another retractive phenomenon.

We know that there are tremendous static forces of retractive nature in these cases of massive collapse. Under such conditions with retraction enlarging cavities, it appears there is no hope for the cavities other than surgery. I would like to ask if my conception of that is correct.

I remember one case in the medical school. The patient had a narrow band of dense tissue down the left side of the thorax. The heart and mediastinal structures were displaced completely to the left side, with a part of the right lung appearing to the left of the sternum. Fortunately, she did not have a cavity.

I would like to have you answer the above question, if you please.

DR MAXIM POLLAK (Peoria, Ill.) I believe that, in addition to the type of cases Dr. Gatterdam has shown, we meet with atelectasis rather frequently in the course of artificial pneumothorax treatment. When we collapse the lung to such a high degree that it shows up on the x-ray film as a small dense shadow, we have produced an artificial atelectasis by our treatment.

I would like to ask the Doctor if he has seen the shifting of the mediastinal structures to a normal position with the use of phrenicectomy.

I have under my observation a case of massive atelectasis which developed last February, in which the heart is entirely on the right side, the afflicted side. We have tried to do everything in that particular case including pneumothorax, but we have not succeeded in relieving the condition. I am wondering if with phrenicotomy we could shift back the mediastinal structures to their normal position.

DR PAUL C. HODGES (Chicago, Ill.) I have been brought up to believe that the mediastinal displacement to the affected side so frequently seen here in unilateral tuberculosis is due to fibrosis of lung and pleura followed by contraction of fibrous tissue. But Dr. Gatterdam proves conclusively that in many cases at least the condition is atelectasis without pleural adhesions. Some of his slides in which the roentgenogram made after pneumo-

thorax demonstrates a completely atelectatic lung without any evidence whatever of pleural adhesions, are literally astonishing

DR. GATTERDAHL (closing) In answer to Dr Snure's question regarding the presence of tuberculosis elsewhere in the lung, we find that cavities are usually visible in the upper lung field of the involved side. There also is usually infiltration or caseation present in other parts of the lung. In addition, there may be activity in the opposite lung.

The case in which the atelectatic lung re-expanded was reported previously. It occurred following a hemorrhage. Artificial pneumothorax was attempted but was unsuccessful because of lack of free pleural space. A phrenico-exeresis was done, followed by a blood transfusion. The atelectasis occurred three days following, and aeration did not take place until about ten days later. Unfortunately we could not follow this case roentgenographically during this time, but, from physical examination, aeration seemed to progress slowly.

As stated before, cavities, especially those in an upper lobe, that are not closed by the atelectasis as a rule tend to enlarge. Contraction of the lung undoubtedly plays an impor-

tant part in this enlargement, primarily caused by the marked negative pressure, and, possibly, secondarily by the resultant fibrosis which occurs.

If atelectasis has occurred, cavities previously present may have become closed or may not be seen through the opacity. Of course, we must remember that in the cases here reported tuberculosis was only considered. Atelectasis may occur in any chronic lung infection such as bronchiectasis, malignancy, or abscess formation. In tuberculosis, if cavities are not seen following an atelectasis, in all probability they will be found if an earlier film has been made. However, I do not wish to make the statement that a cavity must be present.

In cases in which phrenico-exeresis is done, we have not seen the heart and mediastinum return to their normal positions. The additional rise or paralysis of the diaphragm many times helps to close cavities.

If possible we should determine whether or not atelectasis is likely to occur and institute pneumothorax before its development. It is possible, if this is done, that re-expansion of the lung may occur when the pneumothorax is discontinued, whereas after it is instituted on an atelectatic lung, re-expansion is not the rule.

## WHOLE ANIMAL EXPOSURES TO HIGHLY FILTERED GAMMA RAYS<sup>1</sup>

By W. G. WHITMAN, M.D. School of Hygiene and Public Health,  
Johns Hopkins University, BALTIMORE

### I. INTRODUCTION

SINCE the development of high voltage x-ray tubes operating at voltages of the order of a million volts the question of adequate protection for those engaged in this work against the very penetrating gamma-rays which are produced in appreciable fraction of which passes through whatever shielding may be used has become of considerable importance. More and

more laboratories are expending efforts in this direction a development which makes not only possible but practical the use of such tubes for medical applications. Roughly speaking, an x-ray tube operating at a million volts and 4 ma. gives off as much radiation as would be obtained from 1,000 grams of radium, and when 4 or 5 inches of lead is used to shield only 4 or 5 grams of radium the magnitude of the protection problem for those working with such tubes is readily seen.

For this reason it seemed valuable to per-

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1911. Also before the Society of Hygiene of the Johns Hopkins University, Dec. 17, 1911.

form some experiments with highly filtered gamma-rays from radium in order to ascertain the dangers from exposure to such penetrating radiation. Estimates of the protective measures required and the dan-

gross biologic effects of whole-body exposure to radiation of this hardness of voltage-equivalent do not appear to be available in the literature. It might also be remarked that an x-ray tube operated at, say, 1,500,-

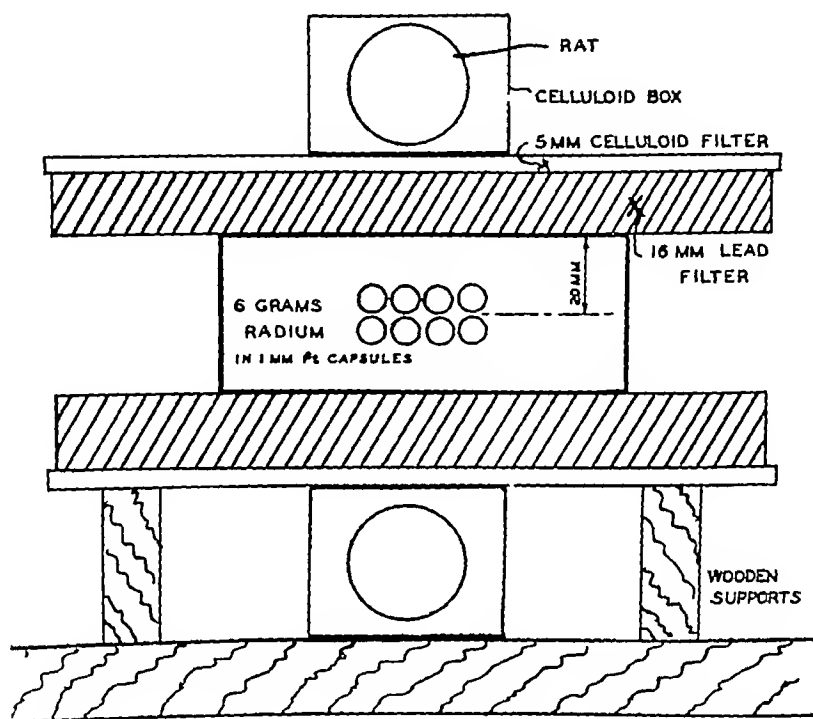


Fig 1 Diagram showing method of exposure of rats to radium

gers involved doubtless might be made from previous work, but for comparison it appeared desirable to have data on exposures to gamma-rays from radium from which all soft components were filtered out, thus approximating the quality of the radiation which passes through the protective screening of a very high voltage tube.

It may be well to point out that in the usual clinical application of radium without heavy filtration a considerable part of the radiation has a wave length equivalent of from 300,000 to 600,000 volts. Filtering with 16 mm of lead, as was done in these experiments, raises the average hardness of the radiation to a wave length equivalent of about 1,250,000 volts. Data for even the

000 volts will give out most of its radiation in the region below 1,000,000 volts, and, due to the lack of filters of higher atomic number than lead, even extremely great filtration will hardly raise the average hardness of the radiation to a wave length equivalent of 1,000,000 volts. The experiments here described may consequently be considered as a valid attempt to obtain primary data of interest in connection with the protection problem as indicated.

## II METHOD OF EXPOSURE

A total of 83 rats was used in these experiments. The stock originally came from the Wistar Institute but had been carried for twelve years by the School of Hygiene

and Public Health of the Johns Hopkins University as a stock colony for the Department of Physiology. Of these rats, 38 averaged 111 days at date of irradiation, 28 averaged 64 days, and 17 were approximate-

throughout the entire body of the rat (Fig 1)

In addition, 16 of the 64-day-old rats were exposed to 2.5 grams of radium at the same distance but with the lead filters re-

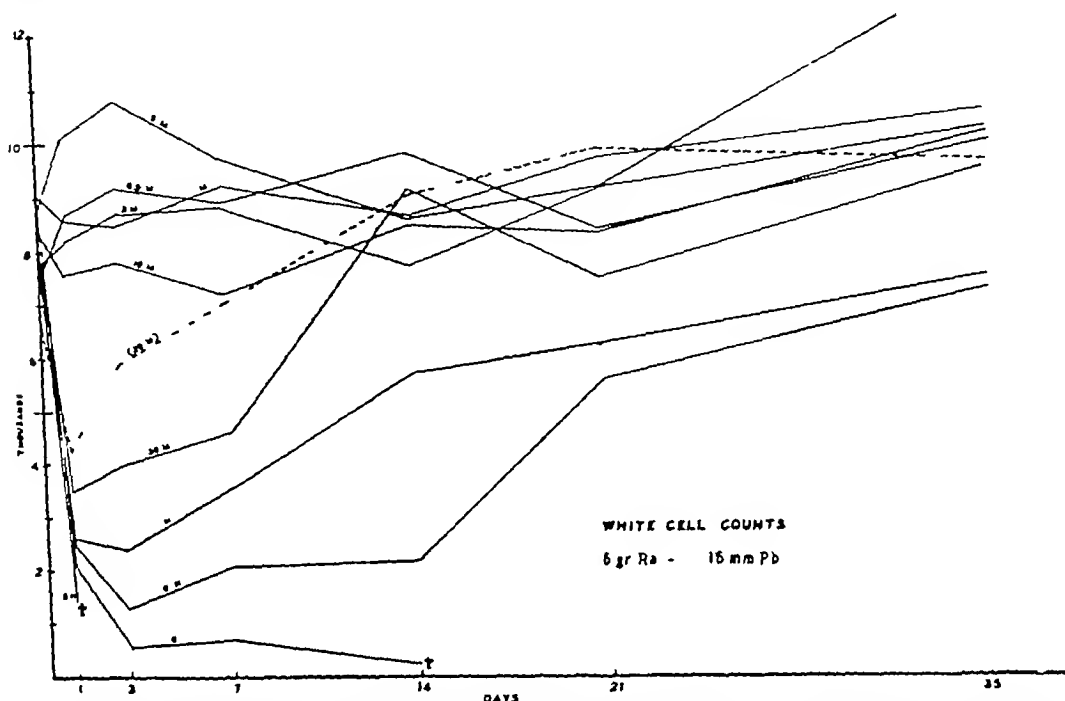


Fig 2. White cell counts on 111- and 64-day-old rats exposed to 6 grams of radium filtered through 1 mm platinum, 1 mm brass, 16 mm lead and 5 mm celluloid. Distance = 62 mm to mid-position of rat. Exposure times, 0.5 minute to 16 hours. Average hardness of filtered radiation had a wave length equivalent of 1,250,000 volts.  
Abscissa: days after radiation  
Ordinate: white cell counts in thousands per cu mm blood

ly 44 days old. A group of 63 rats made up of the 38 oldest, 17 youngest, and 8 of the 64-day-old rats, was exposed to 6 grams of radium filtered through 1 mm platinum, 1 mm brass, 16 mm lead, and 5 mm celluloid at an average distance of 41 mm from the midpoint of the radium to the nearest side of the rat. For 4 additional 64-day-old rats the celluloid was omitted. The rats were put in celluloid boxes 47 mm high placed above and below the radium box. The radium capsules were spread out over a surface 3 by 10 cm to give a more uniform exposure. With this large source area and average distance the exposure was reasonably similar (to within about 50 per cent)

moved, and for 8 of this group the celluloid was omitted. Because of the removal of the lead absorption-filters this group of rats received approximately the same exposure to the hard components of the radiation as the first group using 6 grams of radium and the lead filters, but with the addition of that amount of soft radiation which penetrated the platinum and the brass. The celluloid was used in order to reduce the beta-ray intensity to about the level corresponding to the rate of beta-ray production in the tissues. Exposure times were varied from 0.5 minute to 17 hours in a roughly geometrical progression. It was calculated according to ordinary clinical data that the 2.5 grams of

radium without the lead filter should give an erythema dose in about four hours at the average distance to the middle of the rat of about 6 centimeters

### III RESULTS

(A) *Lethal Dose*—All rats died which were exposed to 6 grams of radium for 6 hours or longer. With a 16-hour exposure,

radium, with filters, therefore, may be taken to lie between 3 and 6 hours. For definiteness, the lethal exposure time under these conditions was taken as 4 hours. Of 4 rats exposed to the 2.5 grams of radium without the lead filter for two hours, 2 died from anemia 19 and 37 days, respectively, after irradiation. The lethal exposure for these conditions was taken as 3 hours.

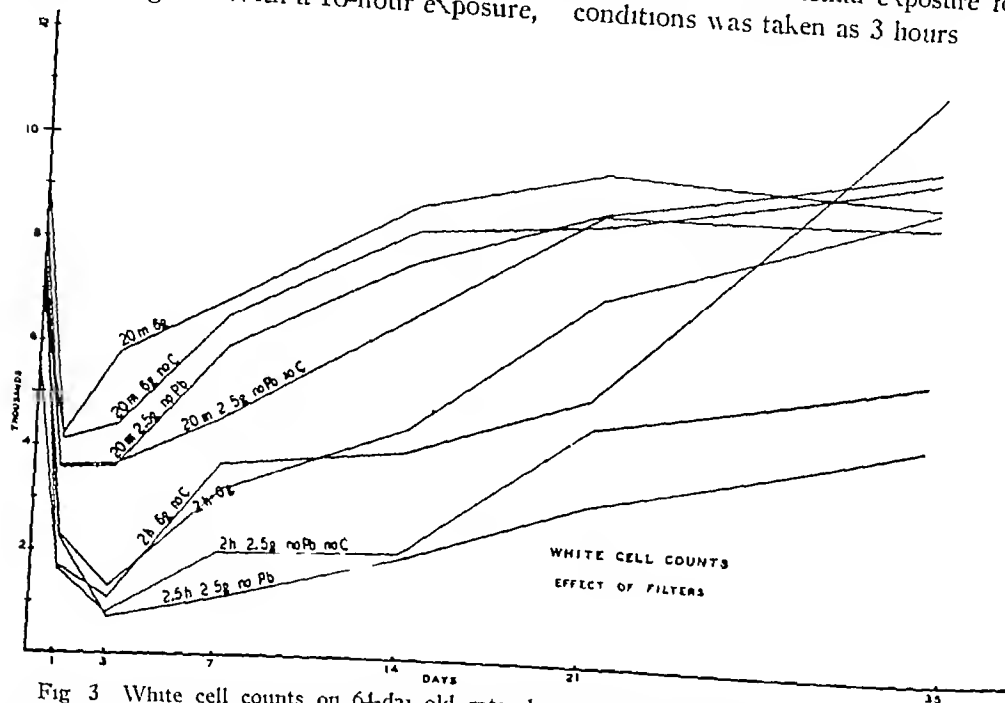


Fig 3 White cell counts on 64-day old rats showing that exposure to 6 grams of radium filtered through 1 mm platinum 1 mm brass and 16 mm lead is practically equivalent to exposure to 2.5 grams of radium filtered through 1 mm platinum and 1 mm brass although rats exposed to radiation containing softer components (2.5 grams, no Pb) showed slower recovery to normal count  
Abscissae days after radiation  
Ordinates white cell counts in thousands per cu mm blood

death ensued in from 2 to 4 days, due (at least in part) to injury to the gastro-intestinal tract. On autopsy these rats showed enormously dilated stomachs, filled with food, and hemorrhages throughout the mucous membranes. Rats which were exposed 6 hours showed some gastro-intestinal symptoms, with diarrhea, but these cleared up in about three days and the rats died from 1 to 3 weeks later with an aplastic anemia. One of the rats exposed 3 hours died from a similar anemia at the end of 11 days. The lethal exposure for 6 grams of

It might be mentioned that in none of the rats were skin effects or burns noted.

(B) *Blood Counts*—It is customary to regard the blood count, especially the white cell count, as perhaps the most sensitive biologic indicator of radiation exposure. Accordingly blood counts were made on 66 rats. All the blood counts were made on the 111-day-old rats except the 20-minute group, which was a 64-day-old group. The exposure arrangement was the same as previously noted. Counts were made before exposure, 0, 1, 3, 7, 14, 21, and 35 days

after exposure The count at 0 days was made from 1 to 4 hours after the end of the irradiation Since a single massive dose is presumably more favorable for causing a detectable change in blood count than the

of from 10 to 30 minutes, 4 rats were in each group, and for the longer exposure times at least 6 rats were used in each group It would appear that since with rats even single doses as large as one-twentieth

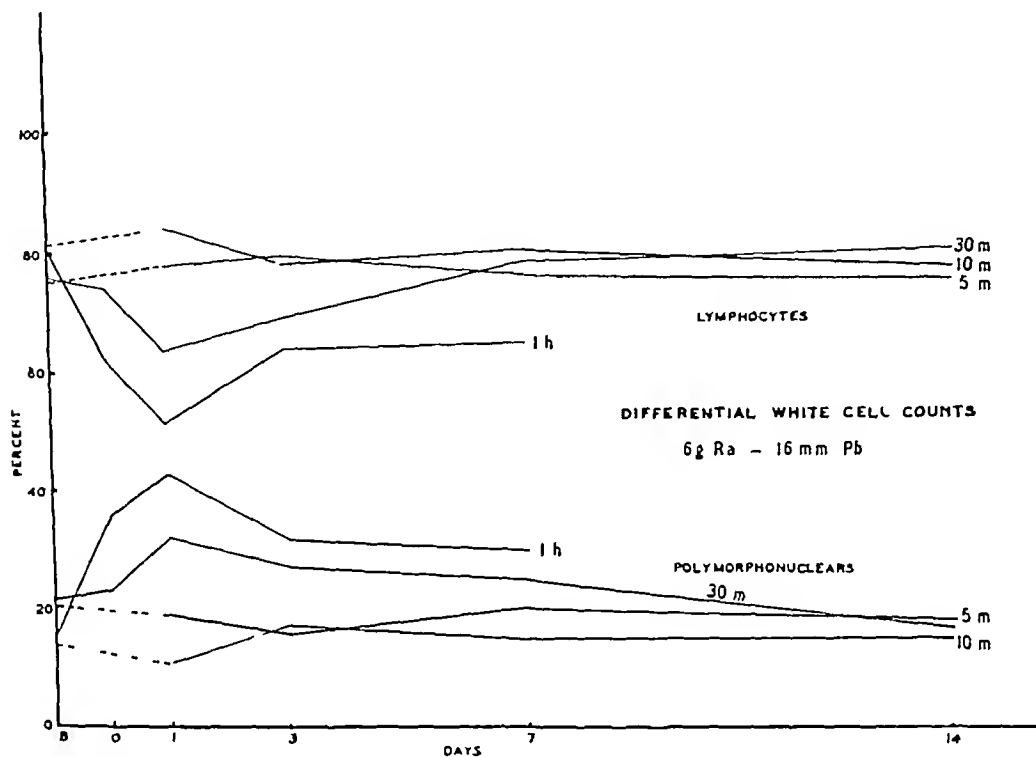


Fig 4 Differential white cell counts on rats exposed to heavily filtered radiation (6 grams radium 16 mm lead 1 mm platinum 1 mm brass 5 mm celluloid) Exposure time, 5 minutes to 1 hour  
Abscissa days after exposure  
Ordinates differential white cell counts

same dosage distributed over a considerable period of time, these observations should give the limiting sensitivity of the blood count method for detecting radiation exposure with rats The minimum exposure which showed a definite fall in the white cell count was about twenty minutes for the rats exposed to 6 grams of radium with filters It is possible that with a larger group of rats than was used in this test an exposure of 10 minutes would show a change which could be considered definite The white cell counts averaged for each group having a different exposure time are plotted in Figure 2 For each of the lowest exposure times only 2 rats were used for exposures

of a lethal dose are likely to escape detection when groups of 4 individuals are used, a dependence on blood counts alone as a danger sign for workers with high voltage tubes may allow an unduly large total exposure to occur unnoticed This is particularly true since the possible cumulative effects of exposure to hard radiation of this type are so far unknown Although one cannot draw any definite conclusions from the small low-exposure groups, it is interesting to note that there is an increase in white cell count for exposures of 5 minutes and less

In order to evaluate crudely the relative importance of the components of the gamma-radiation and of the secondary beta-

radiation from the filters, eliminated in the above experiments using all filters, several groups of rats were exposed omitting separately the lead and celluloid filters. Rats for these experiments averaged 64 days of

nearly the same level as when the 6 grams of radium are used with the lead, with, however, the rat being exposed to such additional softer components as pass through the 1 mm of platinum and 1 mm of brass. The latter filters could not be eliminated in our experimental arrangement. These data are shown in Figure 3.

Differential blood counts were made on selected groups of the rats exposed to the 6 grams of radium, with filters, in order to ascertain whether such a test was more sensitive than the total white count. From the curves of Figure 4 it appears that for this heavily filtered radiation the differential count is not appreciably more sensitive than the total white count.

It is a matter of common experience that the erythrocyte count is less sensitive to ordinary x-ray exposure than the leukocyte count. A similar result was found for the radiation used in these experiments. That the red blood cell counts were consistent with the white cell counts may be seen from Figure 5. Short exposures produced a slight rise and exposures of 30 minutes or more a marked fall, which increased in degree and duration with exposure time.

(C) *Weight Changes*—It may be of interest to remark that with a homogeneous group of rats, such as were used in this experiment, during the significant early period following an exposure to radiation the weight changes were nearly as sensitive an indicator as the leukocyte counts. Lacking a sufficient number of unexposed controls, the groups having an exposure of 5 minutes or less were used as a norm for the rate of growth. This is Curve A of Figure 6. The curves show the weight changes for the various groups of the 111-day-old rats for a period of one week immediately following exposure. A straight line of the same slope as Curve A is drawn through the point which gives the average weight of each group on the day of exposure. It is seen that the other groups fail to gain weight as

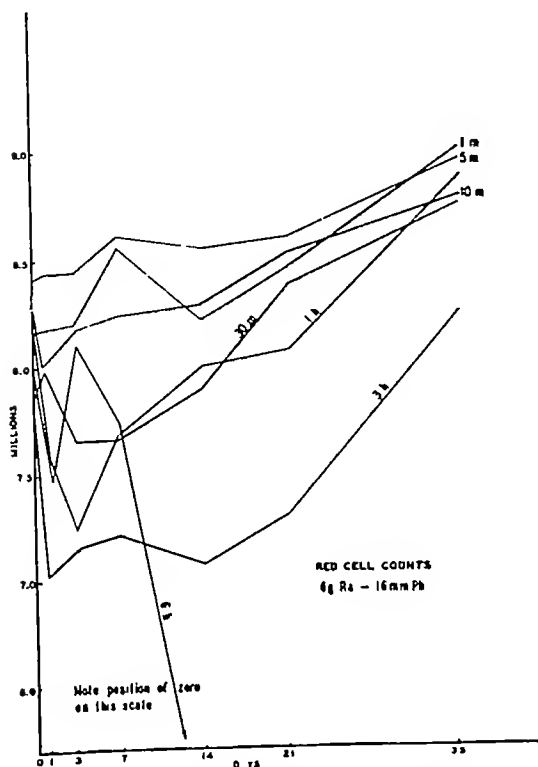


Fig 5 Red cell counts on rats exposed to heavily filtered radiation (6 grams radium 16 mm lead 1 mm. platinum, 1 mm. brass, 5 mm. celluloid). Exposure times, 1 minute to 6 hours.  
Abscissae days after exposure  
Ordinates red cells in millions per cubic millimeters

age. Two groups of rats, exposed 20 minutes and 2 hours, respectively, to 6 grams of radium without the celluloid filter, showed no definite difference from the control rats exposed using the celluloid, which served to reduce the secondary beta-ray intensity to approximately that produced in the tissues themselves. When the 16 mm lead filter was omitted the total quantity of radium was reduced to 2.5 grams which by calculation from the known lead absorption coefficients for the lines of the radium gamma-ray spectrum, should reduce the intensity of the penetrating components to



rapidly as Group A, roughly in proportion to their exposures, and that an exposure of 30 minutes produces at least as obvious a change in the weight curve as the change in white cell count of the 20-minute group of Figure 3

(D) *Estrous Cycle and Breeding Experiments*—Using the standard technic for determining estrus in rats by daily smears, the estrous cycle was followed for 50 days after irradiation in the females which had reached maturity before exposure, and definite normal cycles were found in all rats regardless of the amount of radiation

Data on smaller rats show some evidence that even a moderate exposure of female rats averaging 44 days old on date of exposure delays the opening of the vagina to from 130 to 140 days (the average age for this occurrence is 72 days with a range of from 34 to 109 days)<sup>2</sup>

The rats were not bred until at least one month had elapsed after irradiation. Some rats in each exposure group were bred 3 months or longer after exposure. In rats which averaged 111 days at irradiation, exposed for 1 and 3 hours, respectively, to 6 grams of radium, with filters (total 11, 6 females, 5 males), all of the individuals proved fertile, although 2 of the 6 females showed what is termed "one-time sterility." Hence the sterilizing dose appears to be not appreciably less than the lethal dose for whole body exposure to this penetrating radiation. In view of the observations of Ford and Drips<sup>3</sup> on white rats, it is clear, however, that these meager observations can set only approximate limits on the sterilizing dose.

In the 2-hour group in which the rats averaged 64 days of age on irradiation 4 of the 6 rats exposed to 6 grams of radium with the lead filter were sterile and 3 of the 6 exposed to 2.5 grams without the lead filter, were sterile. It is probably without

significance, but should be remarked, that of these, the 3 sterile rats were exposed without the celluloid, the fertile three with the celluloid. In the 6-gram group, only 2 of the 4 sterile rats were exposed without the

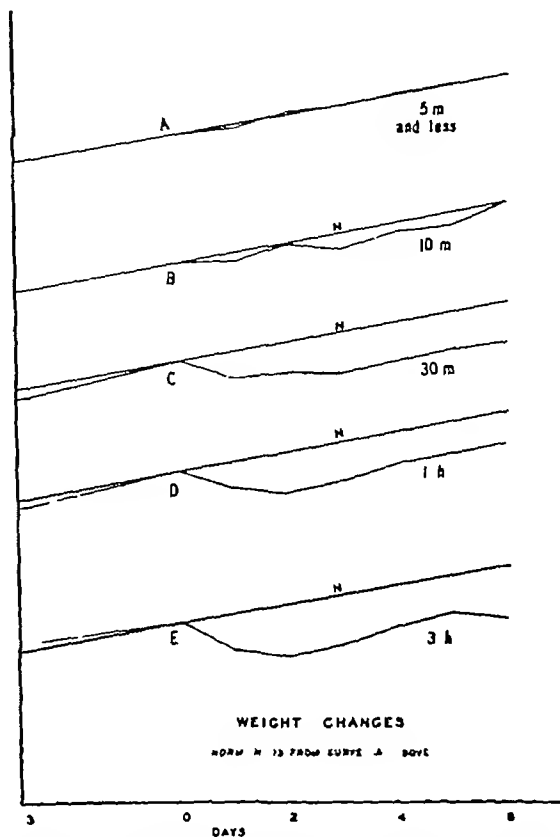


Fig 6 Weight changes in rats exposed to heavily filtered radiation (6 grams radium filtered through 16 mm lead 1 mm platinum 1 mm brass and 5 mm celluloid). Exposure times 5 minutes to 3 hours. N = normal weight curve taken from Group A.

Abscissæ days after exposure.

celluloid. These data merely suggest that young rats which have not reached the breeding age or have barely reached it before irradiation are more easily sterilized than rats which have reached the breeding age before irradiation.

In order to ascertain whether or not an unusually great incidence of abnormal offspring is to be expected in rat families springing from stock irradiated by hard radiation, breeding experiments were carried as far as possible. In the progeny of the rats exposed 30 minutes or more, 7 abnor-

<sup>2</sup>H. H. Donaldson, *The Rat*, 1924.

<sup>3</sup>B. L. Drips and L. A. Ford, *Pr. Staff Meet. Mayo Clin.* January 1932 VII 18-27.

mal rats occurred in 160 offspring. With rats exposed 20 minutes or less, one abnormal rat occurred in 91 offspring. Families showing abnormal rats were inbred and in 74 offspring in the third generation one abnormal was found. In 300 offspring of normal unexposed controls, one abnormal rat occurred.

Abnormalities noted were the absence of one eye or the presence of one large and one small eye. One rat was born with a short tail. These abnormalities occur at infrequent intervals in the parent stock. In both radiated and normal animals, the abnormalities were females and the deformity occurred always in the right eye.

#### IV. CALIBRATION OF DENTAL FILMS

Since it was found that biologic methods of determining exposure for rats, particularly a dependence on white blood cell counts, allowed an exposure as large as one-twentieth of the lethal dose, even when given as a single massive dose, to be suffered without certainty of detection, it is clearly desirable to have a more reliable and sensitive indicator available and calibrated in terms of the lethal effect of this very penetrating radiation. The convenient use of dental film plaques in all x-ray laboratories as detectors of radiation leaks and the exposure of operators, made it desirable to develop a method for utilizing dental film with very hard radiation, providing a suit-

able calibration in terms of its biologic effect. Since soft radiation is photographically much more effective than hard radiation, it is important to measure separately the exposure of an operator to soft and to hard radiations. An unshielded dental plaque is a satisfactory detector for ordinary x-radiation, and a similar plaque well shielded by lead will serve to measure separately the penetrating gamma-rays. To provide a suitable index of exposure of operators to such penetrating radiation, a series of Eastman extra fast (CC) dental x-ray films was enclosed in a lead cassette having walls 6.9 mm thick. This cassette was exposed in the mid-portion of the rat (6.2 cm from center of radium to film) for periods of from 1/100,000th to 1/10th of the lethal exposure time as determined for the rats.<sup>4</sup> For these film exposures, 25 grams of radium were used with the 16 mm lead filter (in addition to the cassette) and 12 hours was taken as the lethal exposure time with this smaller quantity of radium. This corresponds to a lethal exposure time of about five hours, using the 6 grams of radium, instead of the four hours, later adopted as more nearly correct and given earlier in this paper. An exposure of 1/1,000th of a lethal dose gives a point just at the lower end of the straight portion of the density *versus* log-exposure curve, that is 7/10,000th lethal dose gives a density

<sup>4</sup>W. C. Whitman and M. A. Tuve, *Physical Review*, Feb. 1, 1931, **VII**, 330.

TABLE I

Fraction of Lethal Exposure-time	Percentage Transmission Incident Film	Percentage Transmission Emergent Film	Average <i>T</i>	Density = $\log_{10} 1/T$
None	100	100	1.00	0.0
0.00005	100	100	1.00	0.0
0.0001	83	97	0.90	0.045
0.0003	65	83	0.74	0.13
0.0007	46	64	0.55	0.26
0.001	33	45	0.39	0.41
0.003	9.5	12	0.11	0.96
0.007	1.8	1.8	0.018	1.74
0.01	0.71	0.82	0.0075	2.12
0.05	0.028	0.033	0.0003	3.5
0.10	0.028	0.013	0.00012	3.7

easily confused with fog due to development, whereas 3/1,000th gives an obvious blackening of the film. The plaque was exposed as labelled with the black paper toward the tube (radium).

Densities as measured on a photo-electric photometer for the two films in each plaque are given in Table I.

Unfortunately, because of the alterations of photographic contrast introduced in the processes of half-tone reproduction, it is impossible to reproduce correctly the appearance of these films. Figure 7 gives a crude idea, however, for purposes of immediate reference, of the relative densities obtained with the given exposures.

#### V SUMMARY

In order to determine some of the biologic effects of whole body exposure to very penetrating x-rays, unaccompanied by softer radiation, of practical interest in connection with the recent development of high voltage x-ray tubes, a group of 67 rats was exposed to the radiation from 6 grams of radium highly filtered by 16 mm lead, 1 mm platinum, 1 mm brass, and 5 mm celluloid. Another group of 16 rats was exposed to 2.5 grams of radium filtered by 1 mm platinum and 1 mm brass, giving a similar exposure to the hard gamma-rays, with the addition of such soft components as penetrate 1 mm platinum and 1 mm brass.

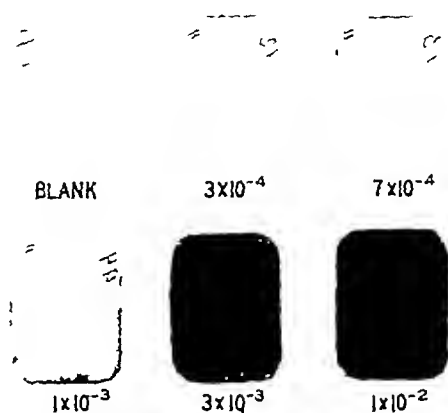
The lethal exposure was found to be 4 hours for 6 grams of radium with filters for a distance of 62 mm to the mid-position of the rat. The minimum exposure which could be detected by blood counts was found to be 1/20th to 1/30th of a lethal dose.

For rats which have reached maturity before exposure the sterilizing dose does not appear to be less than the lethal dose.

Breeding experiments were carried out with the result that the first progeny of rats exposed to more than one-tenth of a lethal

dose showed a small increase in the number of abnormal offspring.

Dental films enclosed in a 7 mm lead cassette were calibrated in terms of the lethal rat dose to serve as a more sensitive meas-



FIGURES GIVE FRACTION OF LETHAL DOSE FOR RAT UNIFORMLY EXPOSED TO FILTERED RADIUM GAMMA-RAYS

LETHAL DOSE 5 HOURS EXPOSURE TO 6 GRAMS OF RADIUM AT 6 CM AVERAGE DISTANCE THROUGH 16 MM LEAD FILTER

Fig 7 Densities of photographic films exposed to definite fractions of a lethal rat dose

ure of the amount of exposure of laboratory workers to such hard radiations.

*Acknowledgments*—This work was carried out during the year 1930-31 at the School of Hygiene and Public Health of The Johns Hopkins University, under the supervision of Dr Janet H. Clark, to whom the writer expresses her thanks. The award of a fellowship by the School of Hygiene and Public Health which made this work possible is gratefully acknowledged.

The writer also wishes to express her appreciation to the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and to Dr M. A. Tuve of that Department for facilities and assistance in connection with the physical aspects of this investigation.

# SOME APPLICATIONS OF PHYSICAL THERAPY IN MEDICINE

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**A**RTHRITIS is one of the most troublesome conditions with which the orthopedist has to deal. If it is of the *traumatic, atrophic, or hypertrophic type*, good results usually follow static sparks for the relief of tension of the muscles surrounding the joint. If it is of the *infectious type*, we are dealing with a general, and not a local, condition. In this case, a redundant and static colon may be as much the inciting factor as infected molars.

If the arthritis has destroyed cartilage, causing fibrosis and ankylosis, our treatment becomes more difficult and painstaking. We must wait for the acute stage to subside, then begin with passive massage and proceed to active exercise. In order to prevent further fibrosis, frequent and oft-repeated exercise is the key, especially in atrophic arthritis with deformity. A low protein diet might also be indicated.

Gonorrheal arthritis is usually chronic. Infra-red therapy, together with diathermy and static sparks, help in a majority of cases. To remember what can be done for disabling gonorrheal arthritis is to recall the work of Major Sampson, during the recent war. He requested that the gonorrheal arthritic patients who had received every form of treatment in the medical, surgical, and genito-urinary departments and were about to be discharged, 100 per cent disabled, be turned over to him. Upon proper physiotherapeutic measures being used—deep therapy lamps, infra-red rays, diathermy, and static massage to fibrosed joints—about 85 per cent were benefited and sent home 100 per cent efficient.

## ELECTROSURGERY

Throughout the country, surgeons are beginning to profit by the methods of electro-

surgery. From the smallest benign mole to the largest malignant infiltration, situated in almost any accessible portion of the body, we find electrosurgical methods indicated.

The two currents used in surgery are desiccation and coagulation. However, these electrical modalities are merely terms. We limit our term *desiccation* to the electrical destruction of benign or superficial growths in which the heat is of sufficient intensity to dehydrate the tissues. This is made possible by connecting our cord with a steel needle to the Oudin outlet of a diathermy machine. By regulation of fine sparks leaving our needle, we are able to remove warts, moles, vascular nevi, exostoses, papillomas, hemorrhoids, and infected tonsils, without even the formation of any discernible scars. Delicate bloodless dissections may be performed, as in the removal of sebaceous cysts, adenomas, or epitheliomas from the eyelids or nose. By using the negative pole of a galvanic machine, superfluous hairs may be rapidly and painlessly removed. A histological study of any growth after desiccation reveals such retrograde changes as shrinkage of cell walls, pyknosis, and cloudy swelling. However, although slightly distorted, the outline of the cell remains.

We also have our urologist desiccate papillomas of the bladder, our ophthalmologist corneal ulcers and growths, our gynecologist urethral caruncles, and our laryngologist small tumors on the vocal cords. The Oudin current is used for all these conditions.

## ELECTROCOAGULATION

Electrocoagulation refers to the deep destruction of malignant tumors in which a greater temperature is used, with more penetrating results. In its effect this modality is

more intense than desiccation. The current is obtained by connecting two cords to the two terminals of a diathermy apparatus. A large inactive electrode is connected to one cord and applied adjacent to the area that we wish to destroy. The active electrode, or needle, would necessarily come from the other cord. With the current on, deep destruction takes place. Histologically, our cells completely lose their outline. Karyorrhexis and karyolysis set in, with thrombosis of the blood and lymph channels.

We can thus readily see how advantageous it would be to destroy a highly malignant growth, sealing the blood and lymph channels, as we gradually proceed in its destruction. The likelihood of metastasis then would become progressively less.

#### GASTRO-INTESTINAL MOTOR INSUFFICIENCY

In studying the motor phenomenon of the gastro-intestinal tract, it is essential to have x-ray films made of the entire system. This will always give us a clew, if any organic pathology, such as ulcer or cancer, is the cause of motor insufficiency. However, once organic pathology is ruled out, the cause for the functional disturbances must be ascertained.

In the study of the colon for motor insufficiency and stasis the barium enema is the best method. Radiographs made after a barium colon enema portray the true conditions existing in the entire colon, from the cecum to the sigmoid. When a case of constipation presents itself it is essential to distinguish between the sluggish colon and the weakened, fatigued colon. In the former, the stimulus to work is absent, in the latter muscular co-ordination. A patient who manifests the symptoms of a sluggish colon complains of digestive disturbances, infrequent, hard and dry stools with a great deal of abdominal distress. A film taken 72 hours after the ingestion of a barium meal would still show stasis in the ascending and

transverse colons. On the other hand, on injection, a barium colon enema would show no defects in course or outline of the colon, but a plate made after evacuation would show a major part of the enema to be retained. This is accounted for by the sluggishness in the muscular coats of the colon.

However, the patient with lack of muscular co-ordination in the colon, due to weakened and fatigued muscles, gives us the history of having loose stools of the dry and hard type. This patient also complains of distention and gas pains for which he has often resorted to cathartics and enemas, frequently with no results. He eventually becomes very nervous. In these patients, gastro-intestinal studies show a nervous colon. Six hours after ingestion of the barium, the head of the meal reaches the sigmoid, indicating a marked colonic hypermotility. After 24 hours, the entire meal is evacuated. A barium colon enema is seen to pass through the smooth colon with great speed. The cecum becomes greatly distended, due to lack of muscular tone, few, if any, haustral markings are noted. Finally, after evacuation, all the barium has left the colon. No resistance whatsoever is offered in its exit. The atonic condition is well borne out by films taken after the expulsion.

#### GASTRO-INTESTINAL TREATMENT

In the treatment of gastro-intestinal diseases, we must resort to surgery if ulcer or malignancy exists. On the other hand, if localized muscular inability or dysfunction exists, especially in the colon, some mechanical action, such as diathermy or galvanism, should be instituted.

The restoration of the tone of sluggish muscles and nerves by hand manipulation and massage was in use long prior to the various electrical modalities of to-day.

#### BONE FRACTURES

In fracture of a bone it is always essential to obtain good apposition and bony

union. However, after this is accomplished, we must then obtain a good functional result. It may, therefore, not alone be in the osseous result but in the functional impairment that physiotherapy is expedient.

Physiotherapy should not be instituted long after damage has been done. It should not be relied upon to rehabilitate cases functionally impaired long after several unsuccessful attempts for bony union have failed. Rather, it should be instituted from the very onset. First the surgeon should obtain the best approximation of the fragment ends possible, the final restoration and co-ordination of the various neuromuscular bundles belongs to the realm of physiotherapy. It is indeed sad to see an extremity markedly atrophied and fibrosed, with no muscular function, after a perfect bony union has resulted.

If it becomes necessary to immobilize an extremity or part of the body in a cast, as in a Whitman spica, windows should be cut into the cast and physical modalities applied in order, at the very start, to prevent atrophy of the nerves and muscles. In some locations it is advisable to split the cast and stimulate the muscles daily. Even in Pott's fracture, in order to stimulate the muscles around the joint, it is advisable to remove the plaster very early and to submerge the foot in the whirlpool bath.

Often one observes that functional restoration of a slight fracture about a shoulder joint becomes a difficult problem. This is, in all probability, due to the great amount of peri-articular infiltration and inflammatory limitation of motion, as well as pain as the sequelæ. Added to this is the adduction and immobilization caused by Jones' position, which virtually plasters and shrinks the nerve and muscle bundles together. More external rotation, and abduction maintained in place by a brace with windows over the deltoid muscle for treatments, would alleviate much suffering in the end. Therefore,

early co-operation between the surgeon and the physiotherapist would certainly lead to better post-fracture functional results in the earliest possible time, eliminating the word "after-treatment" from the reports of the orthopedic department.

#### PHYSICAL THERAPY AS APPLIED TO GYNECOLOGY

Diathermy has been used with good results in many gynecologic clinics, not only in cases of pelvic infection but also in post-operative adhesions.

The abdominovaginal method is employed. Here we place our active electrode in the vagina, put a plate, our inactive electrode, over the abdomen, and use the d'Arsonval current for an allotted time, depending on the lesion we are treating. This method is often used in treating inflammatory diseases, Neisserian infections, and post-operative adhesions. For clearing up such cases as cervicitis and endocervicitis, we rely mainly on electrocoagulation, using a fine-pointed needle as our active electrode.

The part that heat plays in curing disease has long been known. We are familiar with the fact that body heat is a good culture medium for bacteria, any elevation from this temperature has a deterrent effect on bacterial growth. Furthermore, increased heat causes increased circulation, with an out-pouring of leukocytes and antitoxin and a resultant phagocytosis. General metabolism is also speeded up and the weakened and diseased part under treatment is given further aid.

In treating gynecologic diseases by diathermy the abdominovaginal method is the one of choice due to the fact that most heat is generated at the point at which the pathway of resistance is less. An  $8 \times 10$  electrode is placed over the lower abdomen and a vaginal electrode is inserted into the vagina posterior to the cervix. From 1,200 to 1,600 ma. are given, according to the tolerance of the patient.

## CONTRA-INDICATIONS

There are certain definite contra-indications. Diathermy should never be used in the presence of an acute condition, especially if pus has not been evacuated. In cases in which ovarian cysts or tumors are present, the bipolar current is contra-indicated. It should never be used during menstruation, or if open blood vessels exist. It is, therefore, essential that one select proper cases for diathermy, as success or failure in choice determines the prognosis of the patient.

A word might be said also of the use of galvanism in gynecologic diseases. If we bear in mind that the position pole tends to shrink tissue, we can readily see the result of applying this pole to a large, boggy, edematous uterus. Galvanocautery is also used in the treatment of endocervicitis.

## ACTINOTHERAPY AND ITS PHYSICAL APPLICATIONS

The field of dermatology has been enlarged four-fold since the advent of electro- and actinotherapy. Not only has ultra-violet radiation played an important part in the

treatment of skin conditions, but infra-red and x-rays, electrodesiccation, and coagulation have all come to the aid of the dermatologist. The rôle that x-ray therapy plays in skin infections is too well known to need elaboration. The physical agencies used most in skin conditions are the quartz mercury vapor lamp, either air- or water-cooled, electrosurgery, and x-ray therapy.

The effects of irradiation with the air-cooled quartz lamp are not only bactericidal and parasiticidal, but intensive dosages cause desquamation. If greater penetration of ultra-violet is desired, the water-cooled quartz vapor lamp may be used. Many skin conditions, as epidermophytosis, tinea, versicolor, erysipelas, burns, and infected wounds, give good results under proper treatment. We find psoriasis highly resistant to any form of ultra-violet therapy, here x-rays are efficacious.

To reiterate, physical therapy, with its numerous modalities, will quickly come into use as soon as its beneficial results and methods of application become better known to physicians.

CONGENITAL NON-ROTATION OF THE COLON<sup>1</sup>

## WITH CASE REPORT

By MEYER GOLOB M.D. NEW YORK

THIS case of congenital non-rotation of the colon is believed to be of interest, because it represents a rare anomaly, reports of which in the literature are extremely few.

It is not altogether easy to find concise descriptions of the normal positions of the colon in all its parts, neither have we access to comprehensive studies of the anomalies in the location of the colon which are met with in surgical practice, without exhaustive

research of medical journals over a term of years. The rational explanation of this lack is undoubtedly the characteristic absence of clinical symptoms accompanying such anomalies which are for the most part discovered accidentally at operation or post-mortem. As von Bergmann has said, "Abnormalities do not, of themselves produce symptoms but lead to mistakes in diagnosis."

However, with the more facile handling of abdominal section of late years, due in no small part to the superlative advantages

<sup>1</sup>Read before the Staff at Faculty Meeting of the New York Hospital Medical College and Flower Hospital March 8, 1933.



Fig 1 Roentgenogram taken nine hours after the ingestion of the barium meal. Arrow shows shadow seemingly in the rectum. Digital examination revealed a spacious and empty ampulla recti.

afforded by spinal anesthesia, and with the recent enormous increase in explorative and corrective laparotomies, anomaly in the position of the colon is a subject of not a little importance to surgeons.

It is quite possible that, with our increasing use of roentgenography diagnostically and with a more lively interest in reporting these cases, non-rotation of the colon will be found to occur much more frequently than has been thought.

Kantor (1), collaborating with others, recently reported his study of the common anomalies of the duodenum and colon over a period of eight years. He bases his survey on a series of 3,000 private patients with digestive disorders, practically three-fifths of whom were examined by test meals and roentgen surveys in addition to other routine measures. It is his observation that, clinically, anomalies fall into three classes: (1) those incompatible with life, such as complete obstruction, (2) those compatible with life but not with robust health, such as excessive visceroptosis, and (3) those which, under favorable circumstances, do not appear to have any detrimental influence on

health. In the latter—and he thinks it a general tendency—the body as a whole successfully compensates for the anomaly, which remains undiscovered unless the compensatory mechanism breaks down under the influence of mechanical, infective, or asthenic handicaps.

Functional instability as in the neuroses is a contributing factor leading to the denouement of an occult colonic anomaly. This coincides with the pathologic picture of the case herewith presented. My patient had had an anxiety neurosis for some months, with gastro-intestinal symptoms. Routine roentgenography disclosed a marked gastropnoxis and, incidentally, an enteric anomaly consisting of non-rotation of the proximal colon.

Kantor found that the most common congenital anomalies of the colon and duodenum are the so-called duodenal bands known variously as veils, membranes, or adhesions in the upper right quadrant, the redundant, or excessively long, colon, giving an appearance of more than one colon, high cecum, or arrested embryonic development so that the adult cecum occupies a position nearer the liver than is normal, with a shortened ascending colon or none at all, and, finally, the abnormally low cecum, due probably to embryonic hyperdescent.

Much more rare, at least insofar as reports have been published, is the anomaly due to congenital non-rotation of the proximal colon.

Hecker, Grunwald, and Kuhlmann (2) reported a case and made a survey of this anomaly in 1926, their references covering the period from 1815 to 1920. Their bibliography (30 references), while it cannot be considered a complete connotation of reports, is comprehensive enough to justify one in basing thereupon an opinion concerning the rarity of the anomaly. These writers found that the medical literature contains only about forty cases of *sinistrocolia* or *dextrocolia*, that is, the entire colon either



on the right or on the left of the abdominal cavity, or, more frequently, in a position resulting from the non-descent of the cecum. Their important clinical observation is that diagnostic ignorance of the existence of an anomaly and, also, of the types of anomalies the surgeon may encounter unexpectedly upon opening the abdomen, is conducive to fatal surgical accident. Hence they feel that a more comprehensive study is not only a matter of erudite interest to anatomists and embryologists but of practical significance to the surgeon.

Before I report my own case of the rare intestinal anomaly known as congenital non-rotation of the colon, it will clarify our knowledge of the subject to recall the manner in which the digestive tract develops in the fetus.

The primitive alimentary canal is a straight vertical tube, held to the spine by a fold of peritoneum, the stomach first appearing on this tube as an enlargement. The tube below the stomach then grows in the following manner. That portion leading out of the stomach grows with comparative rapidity to form the lengthy coiled small intestine, while the distal portion of the tube grows much more slowly, retains its peritoneal connection with the spine, and eventually becomes the descending colon, the sigmoid flexure, and a partial left segment of the transverse colon.

Now let us imagine a watch laid flat upon the abdomen, with the dial facing outwards. As the large intestine continues to grow, the end which will become the cecum elongates in a course counter-clockwise, the rudimentary cecum pushing farther and farther across the abdomen to the right until it lies at the right under the liver. Then it describes a turn downward following a descending course until it is fixed in its normal adult position relative to the right iliac fossa. This growth movement counter-clockwise, is the so-called normal embryonic rotation of the large colon.



Fig 2 Barium suspension enema before evacuation. Arrows indicate physiologic direction of the parts of the colon, (a) Terminal loops of the ileum in place of the cecum and ascendens.

As Hecker, Grunwald, and Kuhlmann have explained, it is reasonable to believe that development of the large colon can be arrested in fetal life at various stages of growth. The purpose of their study of the reported cases of such anomalies was to formulate, if possible, a usable and easily recognizable classification of the degrees of non-rotation commonly found in these anomalies.

It will be pertinent to follow briefly their classification. They divide malpositions of the large colon into three main divisions: (1) dystopia resulting from faults of normal rotation, counter-clockwise, (2) dystopias resulting from an anomalous *inverse* embryonic rotation *clockwise* instead of the usual counter-clockwise rotation, and (3) dystopia resulting from insufficient fixation of colonic flexures. According to their classification it will help the surgeon diagnostically to recall that arrest of growth may occur at any degree of the growth.



Fig 3 Same as Figure 2. Arrows indicate retrograde direction of the colonic parts, (a) Terminal loops of the ileum.

Thus in the first group—the malpositions persisting in normal embryonic rotation counter-clockwise—stoppage of growth may occur so that the adult state may present any one of the following anomalies (a) No growth of rotation initiated at all, so that the large intestine is in a plane posterior to the small intestine (b) Normal rotation counter-clockwise initiated but growth arrested within the first  $90^\circ$  of rotation, with the small intestine to the right and the large colon to the left. The co-authors of this classification call this degree of arrested development “sinistrocolia of the first degree of normal rotation” (c) Growth arrested after  $180^\circ$  of normal counter-clockwise rotation. This they describe as showing the colon still on the left but the ileocecal region approximating the midline or umbilical line. This degree of arrest they call “sinistrocolia of the second degree of normal rotation” (d) Arrest of growth after  $270^\circ$  of rotation with the cecum in a subhepatic position

but undescended. Called “dystopia of the third degree of normal rotation” (e) Various degrees of arrest in the embryonic descent of the cecum from a subhepatic position to its normal adult position on the right side relative to the iliac fossa.

In the second main classification—or malpositions resulting from an anomalous *inverse* embryonic rotation, that is, clockwise instead of the normal counter-clockwise rotation—growth may likewise be arrested in various stages, which these authors classify as (a) between  $0$  and  $90^\circ$  resulting in their so-called adult “dextrocolia of the first degree of inverse rotation”, (b) between  $90^\circ$  and  $180^\circ$ , resulting in their so-called adult “dextrocolia of the second degree of inverse rotation”, (c) between  $180^\circ$  and  $270^\circ$ , resulting in their so-called adult “dextrocolia of the third degree of inverse rotation”, (d) various stages of insufficient descent of the cecum on the left side in inverse rotation.

I feel that these investigators, by presenting a reasonable and clearly classified diagnostic scheme, have made a worthwhile contribution to our scant published information on the subject of the various anatomical aspects of this condition.

#### REPORT OF CASE

Female, aged 43, married, multipara, negative marital and menstrual history, was referred to me by Dr. Louis Newton. Previous personal history was irrelevant except for an allergic tendency, which manifested itself in a “bronchial asthma” that had lasted for one year at the age of 33, and had recurred recently, continuing for one month. Her present illness was of five months’ duration, with the stigmata of an anxiety neurosis, expressing itself as fear of approaching mental aberration.

The physical findings except for the symptoms of the neurosis and a loss of weight were negative. The symptomatology refer-

able to the gastro-enteric tract was non-inferential. However, a definite hypochlorhydria in a multipara with a subicteric facies was suggestive of biliary tract derangement. This potential diagnosis was refuted by cholecystography. A proctoscopic examination revealed no abnormality. The neurologic findings were negative.

Combined roentgenoscopy and roentgenography of the gastro-intestinal canal were negative except for a marked gastropnoia, with an apparent non-rotation of the proximal colon. The oral method of examination with barium meal and the barium suspension enema method gave a picture of failure of the proximal colon to rotate from the left of the vertebral column to the right and the ileocecal junction was apparently on the outer aspect of the cecum instead of the inner, the terminal ileum occupying the space usually occupied by the cecum and the ascending colon.

Under the fluoroscope a dense shadow was seen in the region of the rectum not accessible to palpation. It conveyed to the examiner the impression of being in reach by a rectal digital examination. However, the rectal examination showed the ampulla empty. Deductively it was reasonable to conclude that the dense shadow was in the cecum.

The interesting features in this case are a negative history referable to the gastro-intestinal canal, an anxiety neurosis of five months' duration, detection of an intestinal anomaly through routine roentgenologic study, and successful anchoring of the pathologic manifestations following institution of psychotherapeutic methods for relief of the functional neurosis.

Developmental arrest of any organ can be explained only by a knowledge of embryology, a lengthy discussion of which does not come within the scope of this paper. So far as the large colon is concerned, as Curnutt (3) has written: "Arrest of development of

migration may result in a high-placed cecum, or the entire colon may still lie to the left of the vertebral column—so-called non-rotation. By failure of the cecum and ascending colon to rotate on their long axes, the ileocolic junction may be found on the outer aspect of the cecum, instead of the inner."

The paucity of symptoms referable to the gastro-intestinal tract in these anomalies, due probably to some compensatory mechanism, explains the usual failure to diagnose the anomaly readily, since the symptoms seldom seem to warrant roentgenologic examination. However, when such patients do present symptoms of a digestive aberration, it is perhaps in some instances due to tossing and churning of the filled colon toward the right abdomen, thereby exerting pressure on the pyloro-duodenal region and giving rise to gastro-intestinal distress. Absence of a bowel syndrome, in spite of crowding of the colon in the left abdomen, may be explained by the fact that there is less space in these instances for the colonic content to travel in its transit to the distal colon. In the case under discussion, the gastro-intestinal tract was singularly free from symptoms and the x-ray study was done merely as a means of reassuring the patient of the absence of an organic etiology for her neurotic stigmata. While such congenital anomalies may not manifest themselves clinically for many years, they afford a link of least resistance in the bodily economy, predisposing to precipitation of pathology from various causes. Left-sided appendicitis is a frequent denouement of congenital non-rotation of the proximal colon. With such a probability in mind the surgeon would not be inclined to make a "button-hole" right rectus incision, but would prefer to make an abdominal entrance of sufficient size to allow him to explore the abdominal cavity with the whole hand.

It is not my present purpose to quote extensively the cases which have been reported

in the literature. However, the several which follow are pertinent as indicative of the varied symptomatology during the diagnosis or treatment of which the presence of the anomaly may be discovered.

intestinal symptoms of constipation, with attacks of diarrhea and recurrent abdominal pains. Following an exacerbation of pain a diagnosis of left-sided appendicitis was made. On operation, the ascending colon



Fig 4 After evacuation, showing entire colon to the left of the vertebral column

Mayo (4), in a series of five cases operated on, three for appendicitis and two for acute abscess, found the anomaly of "left-sided appendicitis" due to congenital non-rotation of the colon. Only one of these was correctly diagnosed from the physical signs and the x-ray before operation.

Delatour (5) reported one case of left-sided appendicitis, undiagnosed until after an exploratory laparotomy was made. A gangrenous appendix was located to the left of the midline, with a subsequent history of fatal peritonitis. In this case, there was a short transverse colon, with the ascending colon crossing the abdomen obliquely, the cecum being entirely to the left of the spine. In another of Delatour's cases, there were

was found in the left half of the abdomen, passing directly up and parallel to the descending colon, with an inflamed and swollen appendix. Delatour's third case, brought to operation because of an erroneously diagnosed cholecystitis, was found to be one of appendicitis, the anomaly being an arrest of embryonal growth of the colon, with cecum undescended from its embryonic subhepatic position.

In Roberts' case (6), the symptomatology suggested a syndrome of reversed peristalsis of twelve years' duration. Many examinations had failed to reveal any tenderness in the right iliac fossa. Non-rotation of the colon was eventually diagnosed from the roentgenogram. I concur with Roberts' con-

clusion from his experience with this case that "the position of the intestinal tract cannot be made out with any degree of certainty by ordinary methods of examination, and during abdominal operation dangerous delay in finding the cecum and appendix may result unless the anomaly has been demonstrated by a previous roentgen examination"

Grove's case (7) is pertinent because of the unusual symptomatology stomach trouble dating back to infancy and frequent attacks of cramps in the left abdomen, associated with diarrhea. The x-ray disclosed that the terminal ileum seemed to be emptying into the cecum from the right, or outer, side instead of at the inner surface of the cecum. This case is unusually interesting because it demonstrates a relationship between an adult digestive inferiority and a congenital anomaly, with treatment directed toward the persistent diarrhea. Eventually operative intervention disclosed the anomaly, which when corrected surgically relieved the symptomatology.

#### SUMMARY

1 Though congenital anomalies of the colon may be symptomless for years, they are a point of least resistance which, under

unfavorable circumstances, will undoubtedly give rise to trouble.

2 Undiagnosed pre-operatively, they predispose to surgical accident.

3 Roentgenographic diagnosis pre-operatively is indicated for chronic abdominal conditions as a precautionary measure to rule out congenital malpositions.

4 A better knowledge of colonic congenital malpositions should be sought as an aid to surgery.

5 A case report is given of the rarely reported malposition known as congenital non-rotation of the colon.

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## THE THORACIC SURGEON AND HIS RADIOLOGICAL CO-WORKER<sup>1</sup>

By WILLIAM A. HUDSON, M.D., F.A.C.S., DETROIT, MICHIGAN

THE thoracic surgeon has at his command numerous methods of investigation which enable him to obtain information of value. He is able to inspect the outside and he may auscultate and percuss the chest as means of determining some of the changes within it or he may inspect the inside of the trachea, the bronchi and

the esophagus through a bronchoscope or esophagoscope as an additional method of obtaining information. After employing any or all of these procedures, there still remains much of the thoracic content about which he is more or less in the dark. However, an additional source may be drawn upon for information and that is radiology. The radiologist is usually and should be called upon before resorting to endoscopy.

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 10 Dec. 4 1934.

The best observers overlook warning symptoms or signs of definite disease at times. In our clinics, where all the recognized surgical procedures applied in the practice of thoracic surgery are constantly being used, where between 2,000 and 2,400 endoscopic examinations alone are performed yearly, our experiences have been such that we no longer feel justified in omitting from our routine examination any investigation that will serve to check our findings. We are so thoroughly convinced of the value of the radiologist and of our dependence upon him for information and counsel in the study of thoracic lesions that we are constantly and continually haunting his laboratory.

At the risk of becoming boresome we would like to review briefly the procedures through which we go during the examination of our patients. Following the history taking and physical examination, and after the routine laboratory work has been carried out, we *take*, and I do not mean *send*, the patient to the roentgen-ray laboratory. We insist upon being present at the time roentgen-ray film records are made and a fluoroscopic study of the chest is carried out in all projections. The roentgenologist is in a position to point out to us the roentgenologic features both from the film and the fluoroscopic studies as they are observed thereby giving us a much clearer conception of the case from a roentgenologic standpoint than any word-picture could do. At the same time the two of us are in a position to correlate the history and physical and laboratory findings with these roentgen-ray studies to the patient's advantage. Certainly any diagnosis arrived at thus will be much more likely to be correct, because of the consideration which each of us will be able to give all the findings, than would a diagnosis reached separately and independently. I know that I have profited greatly by this close relationship with the radiologist while I hope that my radiological friends may

have cause to feel that they too have obtained something of value from the association. The few experiences mentioned throughout this paper are selected from the many I have had with radiologists.

The cry to-day is for early diagnosis especially in regard to tuberculosis and cancer. An early tuberculous lesion or even a large cavity of the lung may be entirely overlooked if one permits oneself to hurry through an examination. For example take the case of a woman who had spat up a considerable amount of blood without warning symptoms. She had undergone previously an operation for removal of an adenoma of the thyroid, left with an entirely satisfactory recovery. Physical examination revealed one or two rales at the left apex anteriorly and near the sternum. Roentgen-ray studies showed a small area of increased density at the same point. It was thought this change might be accounted for by the pressure of the adenoma on the apical pleura, with a deposit of scar tissue. There was no sputum.

The question arose, however as to whether there was a new growth or a tuberculous process present in the left lung or if possibly, the blood came from the food passages. Bronchoscopy was performed and the blood was found to come from the left upper lobe bronchus. No evidence of malignancy was encountered and the opinion was then given that the lesion was a tuberculous one of the left lung. This was later proven by guinea pig inoculation and by smear from the secretion. The patient made a satisfactory recovery under appropriate treatment.

As a second illustration we might cite the case of a white male, 38 years of age who complained of cough and of a pain in his left side, together with loss of weight. He had been through one of our largest institutions where no record of any findings of serious consequence was made. Within three weeks of that time physical examina-

tion revealed a few râles in the central left lung field, posteriorly, and some increase in the pitch of the breath sounds over the same area. The sputum contained tubercle bacilli. Roentgen-ray studies revealed a large cavity in the mid-portion of the left lung near the posterior lateral chest wall. Under collapse therapy, closure of the cavity was obtained.

The first case illustrates the value of endoscopy and history, even in the absence of convincing roentgen-ray findings, while the second illustrates the ease with which a large pulmonary cavity may be overlooked when roentgen-ray studies are omitted.

Frequent recourse to the roentgen ray is necessary in the treatment of pulmonary tuberculosis by collapse therapy. One encounters from time to time men who attempt to administer pneumothorax with no check as to the degree of collapse established other than their interpretation of the physical signs, yet we have found it impossible to estimate satisfactorily without the aid of roentgen-ray studies. Fluoroscopy should be resorted to at frequent intervals, particular attention being given to the following:

- (1) The degree of collapse especially of the diseased area,
- (2) The presence of adhesions which may interfere with the efficacy of the collapse,
- (3) The presence of fluid.

Such observations serve as means of protecting the patient against the establishment of too great a collapse also of selecting cases suitable for the various operations of pneumolysis from that general group in which adhesions interfere with collapse. Finally one must have the roentgen-ray confirmation after a pneumolysis has been performed to establish the fact that an entirely satisfactory result has been obtained.

In the same manner following operations upon the phrenic nerve it is essential that all patients be subjected to fluoroscopic

study of the diaphragmatic function, preferably immediately after the completion of the operation. At such an examination, if the surgeon and the radiologist observe a fixed hemi-diaphragm, or if the affected hemi-diaphragm is seen to act in a manner opposite to normal, they may rest assured that the desired paralysis has been obtained. On the other hand, should any portion of the hemi-diaphragm under investigation show evidence of normal movement, they may rest assured that at least some of the phrenic fibers to that portion of the diaphragm have been overlooked. Roentgen-ray films do not show this reverse or see-saw, action so readily and it is for this reason that resort should be had to fluoroscopy.

The success obtained in the treatment of pulmonary tuberculosis by the more radical operations, that is, thoracoplasties of different types, is to a large extent due to the roentgen-ray evidence collected during the selection of the patients for these operations, and in part to the free use of roentgen-ray studies as a means of determining the degree of collapse obtained following each stage during the operative procedures.

It is difficult to make a diagnosis in a case of early cancer of the lung. As we stated earlier the roentgenologist should be called upon to study the patient in company with the thoracic surgeon before recourse is had to endoscopy. This certainly applies in the case of suspected malignancy of the tracheobronchial tree. *An apparently negative roentgen-ray study should not however, interfere with the carrying out of an endoscopic examination in a patient whose symptoms suggest some pulmonary lesion.*

For instance a white male 31 years of age complained of blood-spitting and of being underweight the former having persisted at intervals over a period of from three and one-half to four years. Numerous physical examinations and roentgen-ray

studies were said to show nothing wrong in the lung fields. Bronchoscopic examination revealed a small nodular mass in the orifice of a posterior medial division of the left lower lobe bronchus and adjacent to this mass was a small ulcerated area. Active bleeding was present from this area at the time. The nodular mass was removed and a microscopic report of adenocarcinoma was made. With the implantation of radium in the bronchus and with the application of deep roentgen therapy, the patient has remained symptom-free for three and one-half years. Bronchoscopic inspection shows no evidence of ulceration or of any mass, and roentgen studies remain free of evidence of newgrowth.

Contrast the above picture with that of a white male, 62 years of age, who complained of shortness of breath and cough over an interval of from six to eight months. He was treated with cough mixtures and tonics and finally a roentgen examination was made. These studies revealed a large area of increased density in the mid-left lung field, in the center of which was an area of decreased density. Because of the age of the patient endoscopic examination was suggested by the roentgenologist. Bronchoscopic studies revealed a fungating mass near the orifice of the left lower lobe bronchus, and that there was considerable pus present. Our impression was that the lesion was a carcinomatous one. Biopsy revealed a squamous-cell carcinoma, and a final diagnosis of squamous-cell carcinoma of the left lung, with cavitation and infection, was made, and confirmed at postmortem. It certainly was not the fault of the roentgenologist that an earlier diagnosis was not made in this case, but the two cases above illustrate one of the points we wish to bring out, namely, an unexplained cough or blood-spitting should lead the roentgenologist to suggest to the clinician the advisability of an endoscopic examination even in the absence of positive roentgen findings.

In an unpublished paper on lung abscess, we have tried to bring out in detail many of the important facts that have developed through our experiences in dealing with suppurative lesions of the lung. For brevity's sake I will mention only one or two of these points. We have noted that the roentgen evidence of lung abscess may vary from a small area of increased density in some portion of a lung field to complete involvement of areas corresponding with one or more lobes of the lung, with evidence of cavitation and fluid level. We are aware of the fact that many roentgenologists do not feel justified in making a diagnosis of lung abscess until such time as they are able to demonstrate a definite cavity in the lung.

In this study we have used the term "impending abscess," especially in relationship to certain types of early changes, and have stated that it is highly desirable for one to make a diagnosis of an impending lung abscess, thereby enabling the clinician to call upon the thoracic surgeon to institute proper treatment rather than to delay until a fully developed cavity with fluid level has formed. In case of a diagnosis of impending abscess treatment may be instituted early and the period of convalescence thereby shortened, whereas, when a diagnosis is delayed the period of convalescence is usually prolonged.

"It is not an everyday occurrence for the general practitioner to encounter a lung abscess and one must not censure him too severely if he does not resort to endoscopy or some conservative method of active treatment at an early date. On the other hand the roentgenologist sees numerous cases and if he has acquainted himself with the progress of other cases that have passed through his hands he can with all sincerity recommend intervention or at least consultation as to the advisability of intervention."

In the beginning of this paper we emphasized the fact that a history was taken before other procedures were carried out.



Later, we stated that an apparently negative roentgen study should not interfere with an endoscopic examination when the history seems to indicate the presence of a definite but unexplained pulmonary lesion. We would now like to point out that *in the absence of a definite history or of physical findings, positive findings in the roentgen-ray studies must not be disregarded and should lead to endoscopy or other confirmatory procedures*.

To illustrate, a white male, 47 years of age, had been subject for many years to what had been interpreted as chronic bronchitis, and had suffered ten months previously from pneumonia complicated by an empyema. The latter had been drained but the drainage tract refused to close, subsequently proper drainage was re-established. The surgeon was convinced that there was present something of an unusual nature which prevented the closure of the empyema drainage tract, and roentgen-ray studies were made. They revealed a shadow in the bronchial tree of the corresponding lung field that closely resembled the shadow of the root of a tooth. The patient was questioned by the surgeon, especially in regard to any operative procedures, including extractions, all of which were repeatedly denied. On the basis of this negative history, even in the presence of such a definite roentgen finding, endoscopy was not resorted to. Later, following manipulation of the bronchi and the instillation of oil by the retrograde method the root of a tooth was expelled. The patient then recalled a previous extraction—more than nine years past. This case illustrates the fallacy of placing too much confidence in a negative history in the presence of positive roentgen-ray findings.

Or again we might illustrate our point through the case of a boy 11 years 6 months of age who gave a history of cough with foul sputum over a period of

seven and one-half years. During this time he had undergone numerous examinations, including roentgen-ray studies. He had been assured that he did not have tuberculosis, but did have an infection in the base of his right lung. He had taken various cough syrups, without relief. On questioning the mother we learned that when the cough developed the symptoms led to a diagnosis of whooping cough. While the boy was supposed to have recovered from that, his cough never did leave him. Our examination revealed evidence of a right basal infection, a temperature of 103°, a severe cough, with foul sputum, and an increased white blood cell count. We started our study with the idea of trying to find a cause for this cough. Roentgen studies were made, using the routine technic for chest films. These films showed a shadow of great density over the right base, extending up to the angle of the scapula. Though no distinctive marking could be seen in this area we were not satisfied with our information. Next with the aid of the roentgenologist, a fluoroscopic study was made. A shadow of slightly greater density than the adjacent structure was noted near the right hilum. Additional roentgen-ray films were made of sufficient penetration—somewhat greater than ordinarily used in studies of the spine—to reveal the area of great density at the right base. When we came to study these new films we had before us the explanation, that is, there was a foreign body near the right hilum—the shadow resembled a wood screw. Bronchoscopy was then performed and a screw, coated with rust was removed. The patient made a complete and rapid recovery. This particular case serves to emphasize not only the importance of looking in the history for a causal factor of the ailment but it also illustrates a point that Dr. Rollin Stevens has often mentioned, namely, that “no roentgen-ray film is too good from which to make a diagnosis.”

studies were said to show nothing wrong in the lung fields. Bronchoscopic examination revealed a small nodular mass in the orifice of a posterior medial division of the left lower lobe bronchus and adjacent to this mass was a small ulcerated area. Active bleeding was present from this area at the time. The nodular mass was removed and a microscopic report of adenocarcinoma was made. With the implantation of radium in the bronchus and with the application of deep roentgen therapy, the patient has remained symptom-free for three and one-half years. Bronchoscopic inspection shows no evidence of ulceration or of any mass, and roentgen studies remain free of evidence of newgrowth.

Contrast the above picture with that of a white male, 62 years of age who complained of shortness of breath and cough over an interval of from six to eight months. He was treated with cough mixtures and tonics and finally a roentgen examination was made. These studies revealed a large area of increased density in the mid-left lung field, in the center of which was an area of decreased density. Because of the age of the patient endoscopic examination was suggested by the roentgenologist. Bronchoscopic studies revealed a fungating mass near the orifice of the left lower lobe bronchus, and that there was considerable pus present. Our impression was that the lesion was a carcinomatous one. Biopsy revealed a squamous-cell carcinoma, and a final diagnosis of squamous-cell carcinoma of the left lung with cavitation and infection, was made, and confirmed at postmortem. It certainly was not the fault of the roentgenologist that an earlier diagnosis was not made in this case but the two cases above illustrate one of the points we wish to bring out, namely, an unexplained cough or blood-spitting should lead the roentgenologist to suggest to the clinician the advisability of an endoscopic examination even in the absence of positive roentgen findings.

In an unpublished paper on lung abscess, we have tried to bring out in detail many of the important facts that have developed through our experiences in dealing with suppurative lesions of the lung. For brevity's sake I will mention only one or two of these points. We have noted that the roentgen evidence of lung abscess may vary from a small area of increased density in some portion of a lung field to complete involvement of areas corresponding with one or more lobes of the lung, with evidence of cavitation and fluid level. We are aware of the fact that many roentgenologists do not feel justified in making a diagnosis of lung abscess until such time as they are able to demonstrate a definite cavity in the lung.

In this study we have used the term "impending abscess," especially in relationship to certain types of early changes, and have stated that it is highly desirable for one to make a diagnosis of an impending lung abscess, thereby enabling the clinician to call upon the thoracic surgeon to institute proper treatment rather than to delay until a fully developed cavity with fluid level has formed. In case of a diagnosis of impending abscess treatment may be instituted early and the period of convalescence thereby shortened, whereas, when a diagnosis is delayed the period of convalescence is usually prolonged.

'It is not an everyday occurrence for the general practitioner to encounter a lung abscess and one must not censure him too severely if he does not resort to endoscopy or some conservative method of active treatment at an early date. On the other hand the roentgenologist sees numerous cases and if he has acquainted himself with the progress of other cases that have passed through his hands he can with all sincerity recommend intervention or at least consultation as to the advisability of intervention.'

In the beginning of this paper we emphasized the fact that a history was taken before other procedures were carried out.

# DEPTH DOSE CALCULATIONS FOR SUPER-VOLTAGE X-RAYS<sup>1</sup>

By M. A. TUVE, WASHINGTON, D. C.

DEPARTMENT OF TERRESTRIAL MAGNETISM, CARNEGIE INSTITUTION OF WASHINGTON, D. C.

*Abstract*—Because of the tendency of those not actually working in this field to assume that raising x-ray tube voltages from 200 to 2,000 kilovolts (2 million volts) will give an increase in penetration and depth dose comparable to that brought about by the change from 20 to 200 K V, calculations were made on the basis of existing published data (1931) to determine roughly the gain in depth dose to be expected with super-voltage tubes. Important factors are the following: (1) Most of the x-rays emitted by any tube have a "hardness" (voltage equivalent) corresponding to less than half of the voltage of the electrons striking the target, (2) lead is the best available filter for very high voltage x-rays, but since it absorbs 2,000 K V (monochromatic) radiation nearly as much as 600 K V radiation, the radiation from a 2,000 K V target heavily filtered by lead will contain more x-rays of voltage equivalent under 1,000 K V than above 1,000 K V, (3) the penetrating power of 2,000 K V (monochromatic) x-rays in water (tissue) is not greatly in excess of that of 600 K V x-rays.

Making approximate corrections for the increase in intensity at various depths due to scattering, from data on radium gamma-rays (Memorial Hospital radium "bomb") the 10-cm depth dose of a 2,000 K V tube heavily filtered by lead is calculated to be 50 per cent

of the skin dose, for a skin-target distance of 50 centimeters. Utilizing the inverse square law, the 10-cm depth dose of a 200 K V tube with ordinary filtering can be raised from 40 to 48 per cent of the skin dose by changing the skin-target distance from 50 to 100 cm (the power input to the target would have to be increased four times for the same exposure times, of course). Thus, although the proportion of the *primary* radiation which reaches the depth of 10 cm is very different in the two cases, the actual dosage being by effectively much "harder" radiation with the 2,000 K V tube, no extreme gain in depth dose is to be expected by using very high voltage tubes (unless intense atomic nucleus x-rays are excited, a phenomenon not to date discovered nor expected). It is emphasized that "depth dose" in this connection does not represent radiant energy flux nor energy absorbed from the beam, but the ordinary usage of the term to represent the empirical reading of a good small chamber ionization meter. Biologic effects may differ widely for the same depth dose at two widely different values of average "hardness" or voltage equivalent of radiation, hence *no biologic conclusions are to be drawn from the calculations outlined*. The writer very strongly takes the position that only careful and extended experimental tests with very high voltage tubes can determine their biologic and therapeutic value.

## INTRODUCTION

It is desired to calculate approximate water phantom depth dose curves which will apply for x-ray tubes operated at voltages above 500 kilovolts. Physical laboratory measurements long since established the approximate monochromatic absorption coefficients for water, and it may be assumed that

these will apply well enough also for biologic tissue, which is largely water, with the balance of the atoms present having approximately the same average atomic number as water. Corrections at various depths due to scattering can be obtained approximately from published water phantom measurements with the Memorial Hospital radium pack ("bomb"). Lead has the highest atomic number of all non-radio-active ele-

<sup>1</sup>The preliminary report of this work was presented at the Dec. 1, 1931, meeting of the Radio-Physical Society of North America at St. Louis.

From a technical standpoint a film may be apparently perfect, but because of the particular circumstances surrounding the case it may be worthless.

Dr. Chevalier Jackson and his associates have so frequently spoken of the importance of two-way fluoroscopy as an aid in the removal of foreign bodies, that we need only remind you of its great value and suggest that the thoracic surgeon and radiologist will be able to work together to better advantage at such times as two-way fluoroscopy is needed, if they have had intimate contact in the fluoroscopic room during their routine work.

To illustrate, a white female, 19 years of age, was subject to frequent attacks of malaise and temperature. Repeated physical examinations were reported as being entirely negative. Studies of the urinary tract revealed nothing abnormal. Roentgen-ray studies, including a supraglottic lipiodol injection of the chest, added no diagnostic information. Because of a slight cough, bronchoscopic examination was done and the orifice of one secondary bronchus was seen to be inflamed. An aspirating tube was inserted into this bronchus from which pus was aspirated and replaced by 20 c.c. of lipiodol. The roentgen studies were then repeated, revealing a triangular area at the right base filled with the lipiodol. At operation an old encapsulated empyema was drained, and the patient's symptoms were relieved. This case is cited to bring out the fact that at times it is necessary to resort to special methods of using a contrast medium in order to obtain the most satisfactory information from a roentgen study.

We might cite one other instance that of

a white female, 38 years of age, who had swallowed lye at the age of two years and had been treated by dilatation of the esophagus. She had passed 36 years of her life with practically no distress, though she did find it necessary to eat slowly and to chew her food thoroughly. Twenty-four hours previous to the time we saw her she had choked while eating, and following this accident no food would pass into the stomach and she felt a definite discomfort in the lower esophagus. Saliva was not drooling from her mouth and she could take small quantities of fluids. An esophagoscopy had been attempted, but the stomach had not been entered with the esophagoscope, because it had been feared that the scarred esophageal wall might be torn. The question came up as to whether or not any food particle had lodged or whether the patient, who was of a nervous temperament, imagined the obstruction. A barium mixture was given, following which fluoroscopic and roentgenographic studies revealed a fairly normal lumen throughout the upper two-thirds of the esophagus, but the lower third was narrow and obstructed—in fact one could see a splitting of the barium column at an obstruction, suggestive of a foreign body. Esophagoscopy was performed and a piece of meat was removed with relief to the patient.

The many articles appearing in the literature on the subject of contrast media and their use in roentgen-ray studies signify the great value of the various media. Contrast media lose none of their importance when used in studies of thoracic diseases. In this field also the close co-operation of the thoracic surgeon with the roentgenologist is an important factor.

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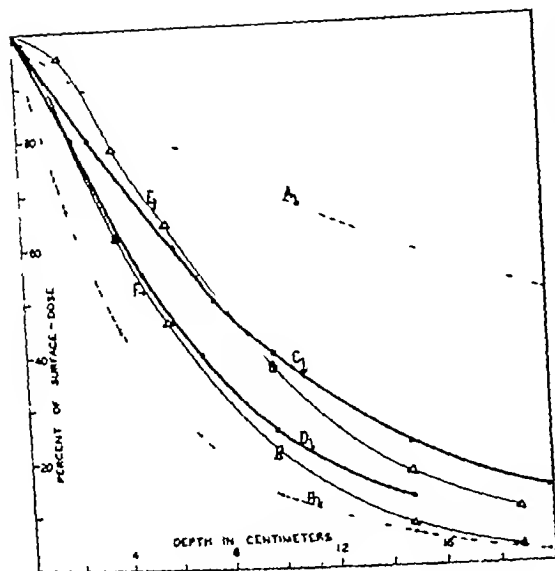


Fig 2 Water phantom depth dose curves [A = inverse square law only, B = theoretical depth dose without scatter, obtained by inverse square law plus absorption, C and D after Bachem (1923), 200 K.V., 1 mm copper, for 20-cm square portal and for 5-cm square portal, E and F after Weatherwax (1930), 200 K.V., 0.5 mm copper 1 mm aluminium, for 20 cm diameter portal and for 5.5-cm diameter portal]

given by different observers are not important here. To indicate the importance of the correction for scattering, curves are given in Figure 2 for water phantom measurements with 200 K.V. tubes at 50-cm skin-target distance. Curve A is the inverse square law decrease without absorption. Curve B is the depth dose to be expected without scattering, comprising the inverse square law and absorption (using absorption coefficient for 100 K.V. as an average hardness). Curves C and E are experimental water phantom measurements with 20-cm portals and Curves D and F the same with 5-cm portals. The scatter correction is then the amount by which Curve B must be increased at each point to reach the experimental curve.

Similar water phantom depth dose curves for the very much harder radiation from the Memorial Hospital radium pack (bomb) are given in Figure 3. Curves A, B, C, and

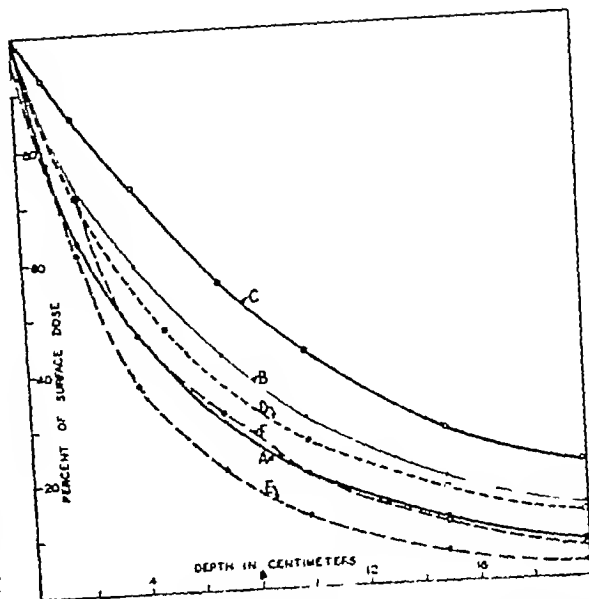


Fig 3 Depth dose curves, Memorial Hospital radium pack [A, B, and C = water phantom for 10-cm, for 15-cm and for 20-cm radium-skin distance, D = intensity in air (nearly inverse square), E and F = theoretical depth dose without scatter, for 10-cm and for 20 cm radium-skin distance.]

D are the experimental values, and Curves E and F are the expected values without scatter (inverse square and absorption, taking average hardness as 1 000 K.V.) which correspond to the experimental Curves A and C. The percentage increase of the dosage at various depths due to scattering, is given in Figure 4 for two values of radium-skin distance. Because of the very large "portal" through which the rays strike the phantom for a radium-skin distance of 20 cm and even for a distance of 10 cm the scattering correction curve for a radium-skin distance of 10 cm may be considered as a generous allowance for the dosage increase due to scattering which may be expected when using a high voltage tube giving radiation of equivalent hardness but with properly defined portals. From the absorption coefficients of Figure 1 and the inverse square law (Curve  $1/r^2$  of Fig. 5) the depth dose curves for monochromatic x-rays are then calculated for a skin-target distance of 50 cm (Fig. 5). The dotted curves represent the calculated depth

ments, and is consequently the best available filter. Its monochromatic absorption coefficients for various wave lengths have been measured and are in the literature. The exact law governing the spectral energy dis-

tribution at various depths will differ greatly with the tube voltage, even though the depth dose remains relatively constant, *no conclusions can be drawn from these calculations as to the relative biologic effects*

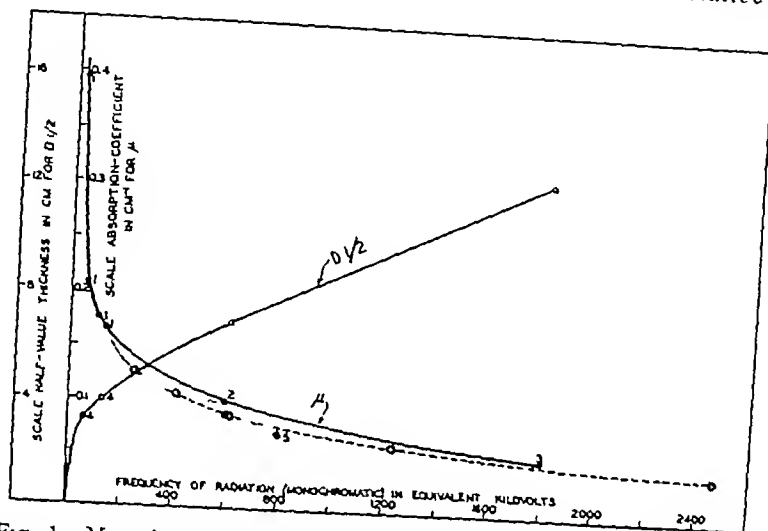


Fig 1 Monochromatic absorption coefficients for water [Points 1 after Richtmyer, points 2 and 3 after Kohlrausch,  $\mu_1$  and  $\mu_2$  (radium), points 4 after Kirchner, double circles after Klein-Nishina formula, and square 5 after Neukirch-Gray (0.26-cm lead)]

tribution to be expected from an x-ray target at various high voltages is not known. All measurements so far made, however (in the ordinary x-ray region) indicate that the intensity from any target is a maximum at the lowest frequencies, decreasing almost linearly to zero intensity at exactly the "quantum limit" corresponding to the (uniform) energy of the electrons striking the target. From these measurements it also appears that the total energy emitted as x-rays with various applied (high) voltages may be expected to lie between the limits (1) x-ray efficiency proportional to voltage, and (2) x-ray efficiency constant for all voltages. The exact shape and magnitude of the spectral energy distribution curves will not be important to our calculations. From these published data it is, therefore, possible to obtain an approximate idea of the depth dose curves to be expected at various high voltages. Since the "hardness" of

to be expected with very high tube voltages. Because of possible misunderstandings on this point, the writer has hesitated for a long time before agreeing to publish these calculations.<sup>2</sup>

#### SUMMARY OF CALCULATIONS

The monochromatic absorption coefficients as measured for water are shown in Figure 1. The curve marked ' $D/2$ ' gives the half value thickness of water for various frequencies. Small differences in the values

<sup>2</sup>Note added in press. In a personal communication to the writer Dr. C. C. Lauritsen has given the results of some very interesting calculations to be published shortly. He considers (as above emphasized by the writer) that the depth dose readings of an ionization chamber are not a suitable criterion for making comparisons between medium and very high voltage radiations. He calculates instead the total energy (in the form of radiation) which can be delivered into the body for a given amount of energy absorbed in the skin. On this basis there is a distinct improvement with increased voltage of the order of a factor of 1.8 in changing from 200 to 600 kilovolts tube voltage. He further points out that the depth dose at 15 and even 20 cm is of importance, and here the harder radiations have a large advantage over 200-kilovolt x-rays. The writer originally presented and here records the empirical calculations of this paper only to indicate certain of the fundamental physical factors which are of importance to the problem.

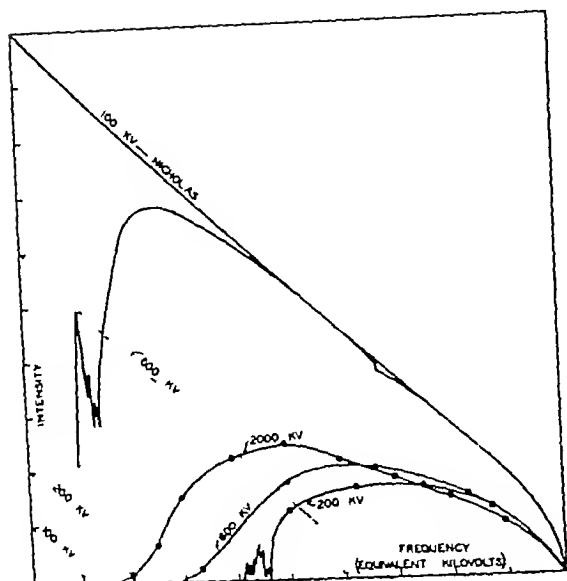


Fig 7 Calculated spectral energy distributions for highly filtered x-rays assuming x-ray efficiency proportional to voltage (see text for detailed explanation) [For a given value of current dotted curves represent intensity distributions on actual frequency—(kilovolt-) scale—area under curves being proportional to  $V^2$ , curve '100 K V—Nicholas' represents intensity distribution at any voltage on percentage frequency scale—area under curve being constant, curves through plotted points represent intensity distributions in heavily filtered beams at voltages as marked]

voltages on a given scale (area under curve proportional to total x-ray output) Hence if the curve marked "100-K V—Nicholas" represents the spectral distribution for 2000 K V the curves for 600 200 and 100 K V will be as shown by the dotted lines in Figure 7 Changing to a percentage frequency scale by magnifying both scales for each dotted curve the curves for all voltages coincide with the curve marked 100-K V—Nicholas' With 2000 K V on the tube if we use a lead filter of such thickness as to give approximately 50 per cent transmission at 75 per cent of the quantum limit frequency by applying the absorption coefficients of Figure 6 we obtain then a filtered beam of x rays having a spectral energy distribution given by the curve marked '2000-K V' (Fig 7) It is clear that the average hardness of such a beam corresponds to monochromatic radiation of a frequency equivalent to less than 1000 kilovolts The

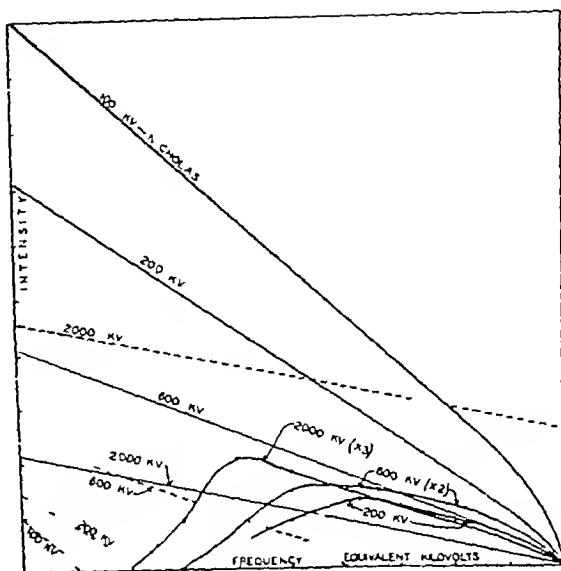


Fig 8 Calculated spectral energy distributions for highly filtered x-rays, assuming x-ray efficiency proportional to  $V^{1/2}$  [As in Figure 7, dotted curves for actual frequency scale—area proportional to  $V^{1/2}$  full-line curves for percentage frequency scale—area proportional to  $1/V^{1/2}$  curves through plotted points represent intensity distributions in heavily filtered beams at voltages as marked (multiplied by labeled factors for legibility)]

much greater extent to which 200 K V radiation may be "hardened" by a half value lead filter is indicated by a similarly calculated curve labeled "200 kilovolts" (The voltage scale is a percentage-of-full-voltage scale for the separate 'filtered' curves and the relative intensities are for points on the same curve, not for comparison between curves The total energy radiated by a target with a given current is greater at 2000 K V than at 200 K V in the ratio of the area under the dotted curves as above mentioned) We may make similar calculations for the assumption that the x-ray efficiency is proportional to the square root of the voltage Using this assumption Figure 8 gives as dotted lines the spectral distribution curves plotted to a fixed voltage scale Reduced to a percentage-of-full-voltage scale the curves are drawn as full lines Applying half value lead filters to the latter curves we obtain the curves drawn as full lines through the calculated points In order to

dose values with no scattering. The full curves are these dotted curves multiplied by the scattering correction marked "10 cm Ra S D" in Figure 4.

We must next inquire as to the greatest

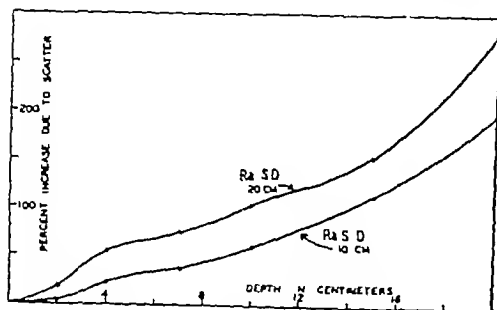


Fig 4 Increase in depth dose due to scattering, Memorial Hospital radium pack.

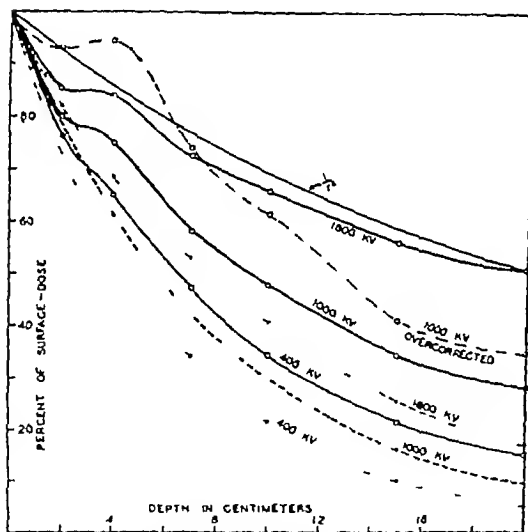


Fig 5 Depth dose curves for monochromatic radiation at 50-cm skin-target distance

average hardness of the beam which we may expect to obtain from a heavily filtered super-voltage tube, operated, for example on a 2-million-volt direct current source. Lead has the highest atomic number of any material available for a filter. It carries photo-electric absorption up to higher frequencies than lighter elements and consequently is the best material available for selectively filtering softer components out of the beam. Even so it does not make an

effective filter for frequencies higher than about 600 kilovolts equivalent. The absorption-coefficients for lead are given for various frequencies in Figure 6.

The remaining factor to be discussed is

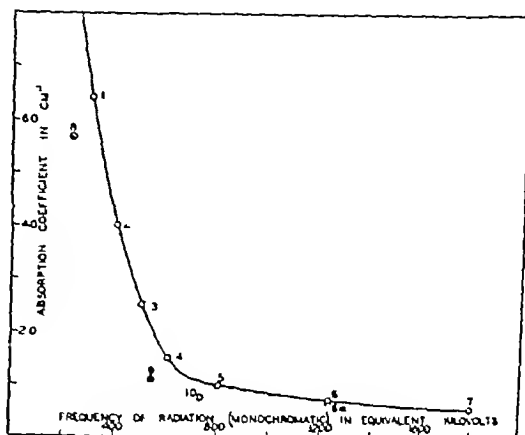


Fig 6 Monochromatic absorption coefficients for lead [1 and 2 after Hermann and Jaeger, 3 after Jaeger interpolated, 4 after Jaeger and Meyer and Schwerdtler, 5 after Gray-Skobelzky, Kohlrausch (Ra 0.35 cm Pb), 6 after Gray-Ahmad (Ra, 1 cm Pb), 7 after Gray-Kohlrausch, 8, 9, and after Compton (older estimates)]

that of the spectral energy-distribution to be expected from an x-ray target at various high voltages. From data in the region 40 to 140 K V Nicholas<sup>4</sup> concludes that the spectral energy distribution for the x-rays produced in the target by electrons of uniform velocity has the form shown in Figure 7, curve marked "100-K V-Nicholas" (this curve is the observed intensity distribution curve as shown in the jagged full line corrected for absorption in the target) and that the total amount of energy converted into x-radiation lies between the limits (1) x-ray efficiency (output/input) proportional to the voltage and (2) x-ray efficiency proportional to the square root of the voltage and is probably near the latter. If we assume the first to be true (x-ray efficiency proportional to voltage) the slope of the distribution curve will be the same for all

<sup>4</sup>W. W. Nichols, Bureau of Standards, Jour. Res. 1930, A 343-563.



reason of the inverse square law<sup>5</sup> The 200 K.V 20-cm portal 100-cm S-T D curves are given as C and D of Figure 10 Figure 11 assembles for comparison a variety of the curves discussed

In closing, the writer wishes to reiterate the fact that, since the dosage at the different depths is produced by  $\lambda$ -rays of very different "hardness" in the two cases, the fact that the 10-cm depth dose with a 2,000 K.V tube may not be expected to differ greatly from that of a 200 K.V tube must not be used for a basis of any conclusions as to their relative biologic effects Only extended and unbiased experimental data can decide the relative value of very high voltage  $\lambda$ -rays in therapeutic work

The writer also records his appreciation that the Chemical Foundation of New York made possible the symposium on physical

aspects of radiation which was presented at St. Louis, and of which this paper formed a part

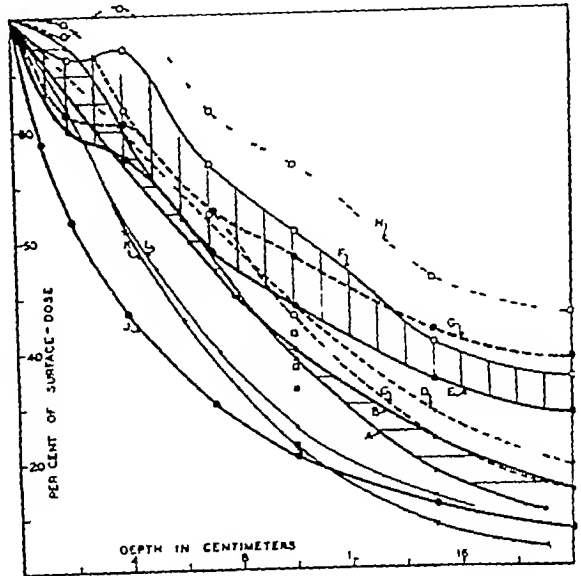


Fig 11 Comparison of depth dose curves [A and B—200 K.V, 50-cm skin-target distance Weatherwax and Bachem C and D—curves I and B corrected to 100-cm skin-target distance, E and F—calculated curves for heavily filtered 2,000 K.V radiation using scattering corrections from Figure 4, at 10 cm and 20-cm radium-skin distance G and H—Curves E and F corrected to 100-cm skin-target distance J—radium pack depth dose, 10-cm radium-skin distance (curve for 20-cm radium-skin distance lies near C) K and L—200 K.V curves, 5 cm portals Weatherwax and Bachem]

<sup>5</sup>Note added in press Dr C C Lauritsen has kindly pointed out to the writer that any increase in depth dose obtained by removing the (point) source of radiation to a greater distance is equally well obtained by the use of multiple portal irradiation This is readily seen as follows Neglecting absorption and considering only the diminution due to the inverse square law on a surface of area A at depth d cm one may obtain a depth-dose equal to the skin dose (100 per cent) by using parallel radiation (strong source far removed) and one portal of area A One may equally well use a source at d cm from the skin and four portals of area A/4 so arranged that each portal gives 100 per cent dosage to one fourth of the skin area while giving 25 per cent dosage to the area A at depth d Any absolute gain in depth dose must come from a decrease in absorption ("harder" radiations) and not from a change in target skin distance

## ANNOUNCEMENT

The Executive Committee announces the Annual Meeting of the Radiological Society of North America will take place during the American Congress of Radiology at the Palmer House Chicago, Illinois September 25 to 30, inclusive

The business sessions will be as follows

Sept 25—Counselors Meeting—Luncheon The names of the nominating committee will be read

Sept 26—Report of the Nominating Committee

Sept 28—Election of Officers

These three meetings will follow the morning sessions of the Congress

Announcement as to room locations will be made in Chicago

Sept 29—Friday night—Convocation and Presentation of the Gold Medals by the Society at 8:30 P. M.

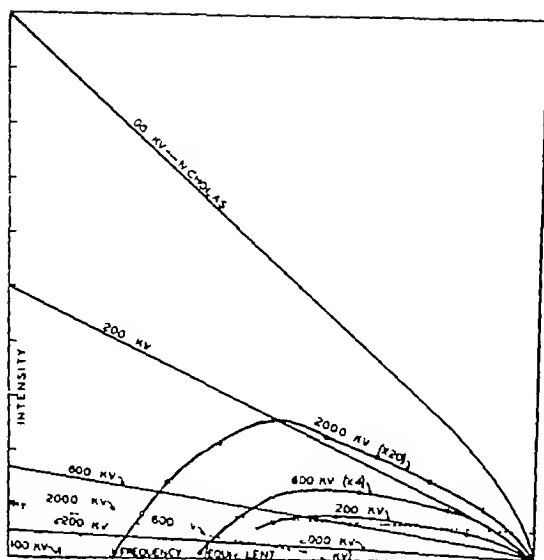


Fig 9 Calculated spectral energy distributions for highly filtered x-rays, assuming x-ray efficiency constant. [As in Figure 7 dotted curves for actual frequency scale—area proportional to  $V$ , full-line curves for percentage frequency scale—area proportional to  $1/V$ , curves through points represent intensity distributions in heavily filtered beams at voltages as marked (multiplied by labeled factors for legibility)]

facilitate visual comparison with the filtered curve for 200 K V, that for 600 K.V has its ordinates multiplied by 2 and that for 2,000 K V by 3. It is again obvious that the average "hardness" of the filtered 2,000 K V radiation is under 1,000 kilovolts equivalent. As an extreme case we might assume the x-ray efficiency to be constant for all high voltages. Curves similarly calculated for this assumption are given in Figure 9. Again, we see that the average "hardness" of the filtered 2,000 K V radiation is under 1,000 kilovolts.

We may, therefore assume for our depth dose calculations for a tube operated at 2,000 K V constant potential that the average "hardness" of the radiation passing a heavy filter will be approximately that of 1,000 K V monochromatic radiation. The depth dose curve for monochromatic 1,000 K V radiation is given in Figure 5 for a skin-target distance of 50 centimeters. We must correct this for the increase due to

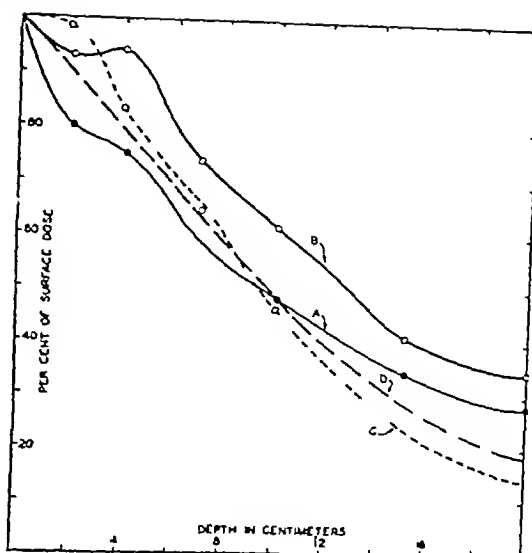


Fig 10 Comparison of depth dose curves [A and B calculated for 2,000 K.V., scatter correction from radium pack at 10 cm. and 20-cm. radium skin distance, C and D 200 K.V. curves corrected to 100 cm skin target distance, from results of Wertheim and of Bachem 200 K.V., 1 mm copper, 50 cm skin-target distance, and 20-cm. portals]

scattering, and, as above mentioned, the curve marked "Ra S D 10 cm" of Figure 4 is a generous allowance. Using these two curves, we obtain Curve A of Figure 10 as the depth dose curve to be expected when using a 2,000 K V tube with a heavy lead filter. To indicate the very maximum which might be possible we may use the scatter correction marked "Ra S D 20 cm" of Figure 4, although this is certainly an overestimation of the scatter correction by reason of the very large "portal" of the radium bomb. This correction gives us Curve B of Figure 10. The 10-cm depth dose of a heavily filtered 2,000 K V tube may thus be expected to lie between 48 and 62 per cent most probably about 50 per cent (of the skin dose). It is of interest to note that the 40 per cent depth dose of an ordinary 200 K V tube with moderate filters and a 20-cm portal (Curves C and F of Fig 2) may be raised to 48 per cent by changing the skin-target distance from 50 to 100 cm. by

On May 3, 1933, the same x-ray dose was repeated, and daily from May 7 to 15, during which time her fasting sugar daily ran from 72 to 80 milligrams

On May 16, June 22, and July 23, one-half x-ray dose previously given was repeated, and her fasting sugar came up from 90 to 100 milligrams

No change in diet was made after beginning the x-ray treatments. Coincident with the improved blood sugar content, her general condition improved, and her mentality rapidly changed over to normal for her age. She now takes zealous interest in all things that interest children, and has no "spells" or stuporous periods. Neighbors, teachers, and child companions comment on her changed condition.

We report this case of hypoglycemia as temporarily improved by radiation alone, making no claim at this time that radiation will cure hyperinsulinism. In this case it seemingly has temporarily, at least, con-

been proven not radiosensitive, but care should be exercised.

### A SIMPLE MANEUVER TO INCREASE THE VISIBILITY OF A SALIVARY CALCULUS IN THE ROENTGENOGRAM<sup>1</sup>

By SAMUEL IGLAUER, M.D., CINCINNATI

It is often difficult to obtain a roentgenogram of a calculus in the submaxillary gland or duct because the shadow of the stone is obscured by the body of the mandible. However, if the roentgenologist places his finger in the patient's mouth and pushes down the floor, the submaxillary gland and duct can be depressed below the jaw bone and the calculus can then be brought clearly into view.

Figure 1 shows a calculus near the angle of the jaw in a roentgenogram taken in the ordinary way. In Figure 2 the same cal-



Fig 1 (left) and Fig 2 (right). See text.

trolled it. We have several other cases under treatment that are showing most gratifying improvement to be reported later.

We can find no reference in the literature reviewed to other cases thus treated. We trust other radiotherapists will test the use of radiation in this condition and report their results. Normal pancreatic tissue has

calculus can be seen to much better advantage below the mandible and the shadow of the finger in the mouth is also visible. The small insert in Figure 2 is from an x-ray film of the same calculus after it had been removed.

<sup>1</sup>Presented at the meeting of the American Laryngological Association at Washington, D. C., May 4-10, 1933. X-ray film by Samuel Brown, M.D.

# CASE REPORTS AND NEW DEVICES

## A CASE OF HYPOGLYCEMIA TREATED BY RADIATION WITH BENEFIT

By S C BARROW, M.D., SHREVEPORT, LA

In reporting the following case, it is not our intention to even touch on the theories as to the causes of a low blood sugar content, found constantly or intermittently in certain individuals, accompanied by severe and alarming constitutional symptoms. We likewise feel uncertain as to the proper designation—spontaneous hypoglycemia or hyperinsulinism.<sup>1</sup>

Relative to the use of radiation in hypoglycemia or hyperinsulinism, we have been unable to find any mention or suggestion of its use in the literature on radiation. In the *American Journal of Roentgenology and Radium Therapy*, September, 1931, A U Desjardins gives a complete review of experiments showing the effects of radiation on the pancreas. None of these reports refer to hypoglycemic conditions, and the general conclusions are that pancreatic tissue and function are rather resistant and non-responsive to radiation. In this review however, of interest to us at this time, are the experiments of Tsuzuki (1926) which showed *distinct atrophy* of the islands of Langerhans in rabbits after full doses of short wave radiation.

### CASE REPORT

On April 16, 1933, Dr. E. Powell, of West Monroe, La., referred the case here reported with the request that we attempt relief by radiation.

The patient, D. W., was a white female aged 9 years, weight 65 pounds, height 52 inches. The general physical appearance was

healthy, mentally she appeared normal in every way soon after eating, but lapsed into dullness and inattention two or three hours after taking food.

She has one brother and two sisters, all normal and healthy. The father and mother claim to be in perfect health. The patient has an aunt, 22 years of age, who has been a confirmed epileptic since childhood (a hypoglycemic case, under treatment and improving, to be reported later), otherwise the family history is negative.

General physical examination discloses no defects, Wassermann negative, tectis, blood counts, basal metabolism rate, all normal. When the patient was 5 years of age, her mother noted that the child seemed to be at times dull, listless, and stuporous, while, again, she was bright, cheerful, and playful. After some time it was noted that her stuporous spells occurred as her meal hours neared, and disappeared after she had eaten. As time passed, she began to have "spells" (so described by her mother), accompanied by unconsciousness. With experience, the mother gradually learned to guard against these attacks by feeding. At the age of 6 years, she entered school and found it uphill work. In the hours immediately after eating she could learn easily, but in her fasting hours she forgot it all, recovering her memory of previous lessons, however, as soon as food was taken.

During all this time, she received no medical attention and was known by the neighbors and school children as weak-minded. About January 1, 1933, Dr. Powell was consulted who at once suspected the true condition. The patient's fasting sugar ran constantly around from 40 to 50 milligrams per 100 cubic centimeters, on feeding every two hours it never went higher than 73 milligrams.

On April 16, 1933, she was given a ray exposure over the anterior and posterior pancreatic areas using 130 K.V.P., 4 ma., 3 mm. Al filter, 15 inch distance, 10 minutes to each area. During the period from April 23 to 30 her fasting sugar daily reached from 70 to 71 milligrams.

<sup>1</sup>To those interested in these phases of the subject we would specially call attention to the following article: Epilepsy and Narcosis Associated with Hyperinsulinism in four Am. Med. Assn. Feb. 4, 1933, C. 3, 13-9. Hyperinsulinism and Hypoglycemia. Endocrinology Jan. Feb. 1932 both by Seale Harris; an editorial in Southern Med. J. 1932, September 1932, and an editorial in Ann. Int. Med. June 1933.

3 *Our Competing Confrères*—Speak well of them or say nothing. Show them by example that we are practising our profession on a basis of fairness to all. In other words, we are putting into action our expressed ideals. Should our competitor be a culprit and do underhand, cut-throat things, that is no excuse for us retaliating in like manner—we would be placing ourselves upon his level and then he would feel justified in "beating us to it."

What do you think about getting as close to our competitors as possible? Familiarize ourselves with their philosophy of life, their good qualities and bad, physical and psychical, material and moral. Would it not be well to organize local groups for mutual advancement by study and free interchange of ideas? Nothing extinguishes the spark of a smouldering fire of impending strife like early frank discussions with all "the cards on the table," and nothing so sets the stage for such discussions as free social get-togethers, where we can grip the hand and use the moniker in greeting.

4 *Our Distant Brothers in Radiology*—Some of us may be situated in large centers associated with clinics, richly endowed research institutions or hospitals of enormous capacity offering opportunities to a favored few. The volume of cases, the variety of conditions and the privileged contacts enable some to secure an envious fund of knowledge. They should share this information. The higher your stratum in whatsoever field of endeavor the greater is your responsibility to those less fortunate. Nothing we gain gives full value until we divide it with others. One should pass on the results of his observations and his achievements. Give to the radiologists less favorably situated your crystallized opinions proven by experiences in order that the sphere of their usefulness may be enlarged by the application of successful methods. Too many good things have been lost to the

world because of lack of whole-hearted distribution of the details of discoveries. Particularly is this fact applicable to the practice of medicine. We brought nothing into the world and we can take nothing away with us. Nothing that we leave to our own flesh and blood, if at the expense of suffering humanity, will ever be productive of good or happiness. Let each and every one of us disseminate our accumulated wealth of personally established worth-while methods. It is the doctors on the rapidly vanishing frontiers who will appreciate and put into practice these humanitarian aids. Stooping to capitalize upon accomplishments in medical science will redound throughout the ages and be recorded on the pages of history—against him who would withhold desirable information except for monetary consideration. Madame Curie and, before her, Professor Roentgen, exemplified the true scientists—they gave to the world the results of their toil and study without thought of compensation.

5 *Our Society*—Many members of our Society and sister organizations, following up and enlarging upon the work of the founders of radiology, have sacrificed life and limb. We to-day are reaping the fruits of their labors. The names of these pioneers will ever be revered. It is incumbent upon us to emulate their triumphs by carrying forward the science so meritoriously inaugurated. They would ask of us nothing more than that we see to it that radio-activity gives the greatest good to the greatest number.

The foregoing thoughts are after meditation upon the state of so-called "detachment" and my humble attempt to see "a way out." You may say that I am visionary, an idealist, that my theories are not workable. How do you know? Try them.

W. H. MCGUFFIN, M.D.

# EDITORIAL

LEON J. MENVILLE, M.D.  
BUNDY ALLEN, M.D.

Editor  
Associate Editor

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## A WAY OUT

The present economic status of the people of the world is the result of disobedience of the "Golden Rule." Some may challenge this statement, nevertheless I am prepared to let it stand.

The remedy for the depressed conditions rests with us as individuals, families, communities, states or provinces, and nations. The individual must get his own house in order, the rest will follow naturally. You can, without stretching the imagination too greatly, visualize a group, a city, or a country made up of persons, each planning, conning, even fighting for all he can corral for himself without thought of his neighbors. This self-centered existence has been in evidence too long. The ego must go. Our social service clubs are waving banners with high-sounding mottoes, but are the personnel of these clubs living in accordance with their preachings? It is not all economic either, one's mental attitude during the depression has made it difficult to distinguish or assess the value of those things necessary or worthwhile, as compared with what was enjoyed in the days of prosperity or what propagandists have proclaimed as our rights. Wars, capital-labor differences, bitter contentions between political parties, religious organizations at variance all have at the

root of their strife selfish motives—coupled, it is true, with misunderstandings and mismanagement.

Let us face this mess with real courage, a determination that we are prepared to do our bit in the reconstruction and re-establishment of world affairs upon a more equitable basis, friendly co-operation, live and let live, and that we are starting right now. "Whatsoever ye would that men should do unto you, do ye even so to them."

How can the members of the Radiological Society of North America apply such a Rule to their specialty?

1 *Our Patients*—We should place ourselves in the position of the patients, conduct such examinations and treatments as seem desirable or necessary, in other words, work 100 per cent in the interest of the patients.

If we are not prepared to carry out the service as we know it should be done, we should not hesitate to call in assistance or refer our patients to another doctor or an institution where we know that they can secure the best.

2 *Our Referring Physicians*—We must play the game, get acquainted with them so that we can communicate with them, expressing ourselves freely and knowing that our statements will not be misconstrued as being officious.

Give them honest reports after painstaking examinations and treatments. We may not be able to tell everything about a case—few are so gifted—but we should give all the information that we have secured since coming into contact with the patient. We must not be afraid to say we do not know or that we consider it advisable to secure other medical opinion.

and even private practitioners to have their indices on punch card systems with their tremendous saving of time and effort. In the compiling of this volume this factor has been duly recognized. From all points of view this book should prove to be an interesting addition to the library of every roentgenologist.

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ROENTGENOGRAPHIC STUDIES OF THE URINARY SYSTEM. WILLIAM E. LOWER, M.D., F.A.C.S., Chief of Department of Urology, Cleveland Clinic, Former Associate Professor of Genito-urinary Surgery, Western Reserve University, Surgeon to Cleveland Clinic Hospital, and BERNARD H. NICHOLS, M.D., F.A.C.R., Chief of Department of Roentgenology, Cleveland Clinic, Cleveland, Ohio. A volume of 812 pages and 812 illustrations. C.V. Mosby Company, St. Louis, 1933. Price, \$16.00.

This volume, conveniently divided into 70 pages of reading matter and 732 pages of illustrations, with explanatory text affords a most comprehensive review of the subject and will have a distinct place as a manual of instruction and also as a reference book in deciding the problems presented in the daily routine.

In the text one is given the benefit of the wide experience of these co-workers in the field of urology and roentgenology. Many practical points in the preparation of the patient and on radiographic technique have been incorporated. The chapter on roentgenographic examination of the male urethra thoroughly covers the points of a procedure that seems to have been difficult to many. Intravenous urography—or as they have suggested in their text, excretion urography—a term gaining in popularity to describe this procedure—is brought up to date in a compact and comprehensive manner which will clarify for many the voluminous literature of the past decade on this subject. The inclusion of a chapter on conditions which affect the upper right abdominal quadrant that often closely simulate and are mistaken for urologic pathologic processes adds distinctly to the value of

this volume. The inset of a schematic drawing in the reproduction of the individual roentgenogram aids materially in the interpretation of the illustrations as presented, and the addition of the history in each case makes it at the same time an instructive text-book and a valuable reference volume. Particularly interesting are the wide range of normal pyelograms, with the variations due to incomplete filling and other reasons, and the renal anomalies. These will, no doubt, be of distinct value to those of lesser opportunity and experience in their doubtful cases.

The book reflects a wealth of material, well segregated and carefully studied, and is a distinct addition to the literature on this subject.

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LES COURANTS DE HAUTE FREQUENCE EN GYNECOLOGIE (High Frequency Currents in Gynecology). A. LAQUERRIERE, Electroradiologist des hopitaux de Paris, Directeur des services d'electro-radiologie et de physiotherapie de l'Hopital Notre-Dame (Montreal), and D. LEONARD, Assistant des services d'electro-radiologie et de physiotherapie de l'Hopital Notre-Dame (Montreal). Preface by Pr. D'Arsonval. A volume of 138 pages with 25 illustrations (Collection *Medicine et Chirurgie pratiques*, No. 52). Published by Masson et Cie, Paris, 1932. Price, 18 francs.

This is a small manual explaining in simple terms the uses of high frequency electrical currents in gynecology. The beginning of the book is devoted to an explanation of apparatus and methods and the latter part to diseases and the high frequency treatment best fitted to deal with them. The subject is well handled and on the whole the opinions expressed are sound and the relative merits of different methods are adequately set forth. As a simple presentation of the question of high frequency treatment in gynecology it may here and there give an impression that this method of treatment is more valuable and that its scope is greater than is actually the case but this is merely due to brevity.

## COURSES IN ROENTGENOLOGY AND RADIATION THERAPY

The New York Post-graduate Medical School of Columbia University, New York City, has arranged to give new courses in roentgenology and radiation therapy this Fall. Any one interested may obtain full information by writing to the Registrar, Mr Louis P. Aikie, 303 East 20th Street, New York City.

a certain appeal to undergraduate students and to clinicians especially those who persist in attempting to make roentgenologic diagnoses by comparing roentgenograms with published illustrations. Perhaps the reviewer is hypercritical, but he feels that textbooks should take pains to correct the too-common notion that the roentgenologic diagnosis of gastro-intestinal disease is utterly simple and extremely facile, and should present the subject in sufficient detail to convey the fact that there is no royal road to this art.

## BOOK REVIEWS

**PEPTIC ULCER. CLINICAL ROENTGENOLOGY WITH CASE HISTORIES.** By JACOB BUCKSTEIN, M.D., Instructor in Gastro-intestinal Roentgenology, Cornell University Medical College, Alimentary Tract Division, Roentgen Department, Bellevue Hospital, Consultant in Gastro-enterology, U.S. Veterans Bureau, Central Islip and Rockaway Beach Hospitals, Associate Attending Gastro-enterologist, Sydenham Hospital. Volume X. *Annals of Roentgenology*, edited by James T. Case, M.D., Professor of Radiology, Northwestern University Medical School. Second Edition, revised. A volume of 417 pages, with 334 roentgen-ray studies, 77 clinical illustrations, and 405 general illustrations. Published by Paul B. Hoeber, Inc., New York City, 1933. Price, \$12.00.

Many specialists in roentgenology will be reluctant to pay the price for this book of slightly more than 400 widely margined pages and its text in twelve-point pica, dealing solely with peptic ulcer. Less than a fourth of the text is generally descriptive, and the remainder is devoted to case reports which are trite, largely repetitive and not particularly illuminating. Lesions depicted are chiefly gross and most of them should be recognized at examination even by a novice. Yet the book is not devoid of merit as a primer and atlas on this theme.

The historical introduction is interesting, and many elementary facts concerning the morbid anatomy of peptic ulcer are presented attractively. On the whole, the book will have

**A STANDARD CLASSIFIED NOMENCLATURE OF DISEASE.** Compiled by the National Conference on Nomenclature of Disease. Edited by H. B. LOCIE, M.D., C.M., Executive Secretary. A volume of 702 pages. Published by the Commonwealth Fund, New York City, 1933. Price, \$3.50.

This compact volume of slightly over 700 pages is the result of a series of conferences instituted by the New York Academy of Medicine in 1928 in an attempt to standardize, if possible, the nomenclature of disease. With the generous financial support of the Commonwealth Fund and the co-operation of representatives of some twenty-two scientific societies and five federal organizations, the Executive Secretary of the National Conference on Nomenclature of Disease has compiled the results of their deliberations in a comprehensive and convenient form.

The interrelations of roentgenology with almost every known branch of medicine and surgery in many institutions and in private practice sharpen the interest of the roentgenologist in an index that will make his material quickly and conveniently available.

With the aid of such a volume as this a non-professional could in time become familiar with the major codes of interest and accurately distribute as a routine procedure the various types of lesion in which there may be something of roentgenologic interest. To those searching for the ideal in indices this small volume will come as a welcome aid. It seems but a question of time before facilities will be available to the majority of institutions



## APPARATUS

Shortcomings of Tank Development Ways for Improvement in the Technic of Development. Hans Lewin *Röntgenpraxis*, May, 1932, IV, 445-451

Tank development, although generally used, is not as ideal as one is led to believe. The quality of a roentgenogram developed in a tank is far inferior to one developed by moving in a tray. How much the quality of a roentgenogram is influenced by the development is unknown to the roentgenologist, however, the importance of time and temperature is known. The mechanical conditions during development have not been studied sufficiently.

Aluminum and lead figures were roentgenographed. The films were developed in a tank and below each shadow of a figure a band-like shadow could be seen, which gradually disappeared in the normal black surroundings. If the film is developed by moving it in a tray, this phenomenon is not present. The explanation is probably a sinking of free bromine, combined with the alkali of the developer. As a developing solution which contains a lot of bromine is slow, the area just below is only partially developed. The medical roentgenogram might show this in films containing lead numbers, but naturally all other shadows of increased density must show the same thing, even if not noticeably. Tank development leads to a loss of contrast. If one puts the exposed film in a tray of water at 20° C and moves it for ten minutes, the development is influenced. It increases the intensity of the developing process so much that only one half of the normal exposure time is necessary. Apparently well controlled exposure and determination of film blackening by a photometer showed that films developed by moving in a tray had a 100 per cent blackening. Films developed and not moved in a tank had only 65.5 per cent. If the film was moved in the tank six times during six minutes, the factor was 96.5 per cent.

If the exposed film is moved about in plain water as previously described, and is then moved about in a tank or tray, the exposure time can be shortened to one fourth of the time as compared with the technic of not moving the film in the tank. The author shows roentgenograms to prove this contention. He suggests the installation of a pump arrangement in the tank to keep the developing solution in constant motion.

H. W. HFFKE, M.D.

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The author presents two case reports of lead poisoning in children calling attention particularly from the x-ray standpoint to the dense lines seen in

the epiphyses of the long bones. This condition has been noted in the last few years by Park, Jackson, Kajdi, and Vogt.

Specimens from autopsy material showed that there was four times the amount of lead in these areas than farther back in the shaft of the bone. Park also demonstrated that microscopically the trabeculae are much more dense in these radiologically dense areas.

While these dense areas are found in other conditions, such as healing rickets, scurvy, and congenital syphilis, yet the associated symptoms are sufficiently characteristic for differential purposes.

Other metals may produce similar densities.

L. J. CARTER, M.D.

Pseudo-fractures in Arthritis Deformans of the Hip. A. Herzog. *Röntgenpraxis*, March, 1933 V 174-177.

Roentgenograms of arthritic hips show occasionally a bandlike zone of decreased density running horizontally through the head, which might present the appearance of a fracture. Three such cases are described. The author believes that this phenomenon is due to an extensive calcification and ossification of the joint capsule, which does not attack a narrow limited zone. It looks on the roentgenogram like a fracture. Movement of the joint and capsule seems to prohibit deposition of calcium in this limited area.

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Fragilitas Ossium and Blue Sclerotics. H. S. Sharpe. *Can. Med. Assn. Jour.* August 1932, XXXII, 174.

This is a case report of a painless fracture of the right humerus produced by a slight twist of the arm. This was the fifth fracture the patient, a young female, had sustained, all being due to slight trauma. Three of the fractures had occurred before the age of fourteen years. On inquiry into the early history it was found that the patient did not walk until the age of five. She wore steel braces to support the legs from that time until she was nine. At the age of fourteen she was treated for scoliosis and wore a cast for six months.

Her eyes exhibited the typical blue sclerotics of fragilitas ossium. Her father also had the same pigimentary defect and had sustained many fractures. One brother also had blue sclerotics and had had many fractures.

A radiograph of the head showed some tendency to thickened islands of bone in the vault and wide suture lines. The long bones showed the cortex to be thin and dense and the medullary cavity comparatively large.

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J E Habbe, M D  
H W Hefke M D  
Nathan Flax, M D

L T Leddy, M D  
H C Oehsner M D  
E A Pohle M D, Ph D  
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## CHEST (DIAGNOSIS)

Pneumoconiosis of Porcelain Workers Leopold Holst Röntgenpraxis, May 1932 IV 409-422

Serial examination of cases with pneumoconiosis (Stages I and II) shows that they do not change their character appreciably in the course of years. One may see changes progressing from Stage I to Stage II, but not to Stage III. In the larger number of cases which presented a roentgen appearance of Stage III, cavitations were seen to develop in time and tubercle bacilli were demonstrable in the sputum. There is no reason to believe that in Stages I and II there is a combination of pneumoconiosis and tuberculosis. Stages I and II, according to the commonly used classification, must be considered pure pneumoconiosis while the picture of the third stage is based not only on a pure silicosis but on a tuberculo-pneumoconiosis.

Patients with silicosis are very liable to acquire a tuberculosis of the lungs. Tuberculosis which complicates a fully developed silicosis runs a slow course (fibrous type) but usually ends with the formation of cavities leading quickly to death. The pneumoconiosis is *per se* a rather harmless disease but predisposes to grave complications. The prophylaxis must be strict. Technical improvements in removal of the dust remove the danger of tuberculous infection from the surroundings of a patient with silicosis. Dismissal of all patients with open tuberculosis from the shops and transfer of all workers with pneumoconiosis of Stage II into dust-free occupations.

H. W. HEFKE MD

Roentgenograms of the Disappearance of a Large Tuberculous Cavity in a Lower Lobe F. Secher Röntgenpraxis, May 1932 IV 434-435

The disappearance of a large cavity in a lower lobe in a few months is not often seen. The author cites a case in which the cavity was the size of an apple and surrounded by tuberculous foci. The sputum of the patient was positive for Koch's bacilli. After a few months the cavity disappeared and the lung was almost entirely free from pathologic changes. Even after two years the patient remained symptom free.

H. W. HEFKE MD

## CONTRAST MEDIA

The Use of Thorium Dioxide in the Diagnosis of Liver Abscess Robert J. Keves and Elbert D. Apple Jour. Am. Med. Assn. May 27, 1933 C 1682-1683

The authors report the use of thorium dioxide in 12 cc. doses with a total dosage of 72 cc. over a period of 14 days to define the liver abscess. Roentgen examination of the abdomen three days after the last injection disclosed a markedly enlarged liver

and a large rounded area of diminished density situated in the posterior portion of the liver measuring 14 cm. in diameter. The abscess was aspirated and about 300 cc. of pus was obtained.

The authors have reviewed the literature and discussed the distribution of the thorium in the tissues and the inherent dangers in the use of thorium dioxide.

C. G. SUTHERLAND MD

Roentgen Visualization of Liver and Spleen with Thorium Dioxide Sol, with Particular Reference to the Pre-operative Diagnosis of Carcinomatous Metastases to the Liver Lester G. Erickson and Leo G. Rigler Jour. Am. Med. Assn. June 3, 1933 C 1758-1764

Radt in 1929, was able to visualize the liver and spleen and demonstrate gross changes very beautifully with a fine colloidal suspension of thorium dioxide. The colloidal particles of radiopaque thorium dioxide are phagocytosed by the reticulo-endothelial cells of the liver and spleen thus casting a shadow of these organs on the x-ray film. The authors report the results of this procedure as a routine examination pre-operatively in cases of malignancy particularly those of the gastro-intestinal tract. In a series of 82 cases of various types they found the clinical application to be surprisingly broad and useful. Elimination is slow and probably occurs through the intestine and the lungs.

The authors have recently undertaken the study of the effect of various drugs in hastening elimination. While most investigators have yet to discover any draining effects when used in the doses necessary for diagnostic valuation it has not been definitely proved that the procedure is entirely harmless. A total dose of 0.8 cc. of thorium dioxide sol per kilogram of body weight gives a diagnostic shadow of liver and spleen when detail is wanted. This is given in three equal doses on successive days. Several times the authors have visualized detail well with 50 cubic centimeters. It is always advisable to give the smallest possible dose. The speed of injection makes little difference but it is important to warm the preparation to body temperature before giving it. The films should be taken not sooner than 24 hours following the last injection and they are better at 48 hours. Interpretation of the films depends on the constancy of the irradiated area as to location and size in a series of films. When in doubt it is preferable to make an error on the negative side.

CHARLES G. SUTHERLAND MD

Thorotrast A New Contrast Medium for Radiological Diagnosis W. H. Dickson Can. Med. Assn. Jour. August 1932 XXXII 125-129

In the latter part of 1930 I and Radt discussed his method of the administration of thorium in a colloidal

solution of high dispersion and low—or no—toxicity, for the study of diseases of the liver and spleen by the radiological method. From then, considerable research has been continuing abroad with the new medium. In September, 1931, Dr. Dickson and his confreres were requested to carry out experimental work in the University of Toronto and Toronto General Hospital.

The radiological work done was supplemented by research work on animals by the Department of Medical Research, Banting Institute, and by the Department of Surgery, both of the University of Toronto. The animal research work was done by Dr. D. A. Irwin, and the surgical work by Dr. I. G. Macdonald. The clinical and animal research findings of these two men are reported in separate papers in the same issue in which Dr. Dickson's paper is published.

Thorotrast is deposited chiefly in the liver, spleen, bone marrow, and lymphatic glands, while smaller amounts are found in the adrenals and ovaries. None has been found in the testicles. Normal lungs and kidneys show no deposit, while in disease of the lungs or kidneys the thorium is found deposited in these organs. No evidence of elimination of thorium from the spleen, bone marrow, lymphatic glands, or ovary has been observed in a period of four months, but there is a small amount from the adrenals. The chief organ of elimination is the liver, about 50 per cent remaining in the liver in three months. This elimination goes on through the central vein of the liver, through the right heart into the lungs, where the thorium-laden Kupffer cells stick in the capillaries and are eventually thrown off in the mucus from the bronchial tubes. During the stage of elimination the thorium is recoverable from the lungs. No reaction was noted in any case.

The technic was as follows: A daily dose of thorotrast was given intravenously, 25 cc a day for three days. On the fourth day films were made. This was repeated daily until the greatest concentration was noted in the spleen and liver.

A well outlined liver, smooth and homogeneous in density, rules out carcinomatous changes. Metastases are seen as areas lacking in density and having a punched-out appearance. Similar appearances are found in the spleen. Cysts in either organ are seen as clear areas. Changes in size of either organ are noted. This method will be found of great value in the differentiation of abdominal tumors in the left and right hypochondrium.

The method is of value in diagnosing brain lesions such as tumors, arteromatous changes of encephalic arteries and meningitis. Thorotrast (8 to 15 cc) is injected into the common carotid through a platinum needle 1 mm in diameter bent or byouet-pointed. The same solution may be used in retrograde urography as well as in fistulous tracts in emphysema and bronchiectasis.

I. J. CARTER, M.D.

## DOSAGE

The Problem of Dosage in Temporary Sterilization by Irradiation. Th. C. Neeff. *Strahlentherapie*, 1932, XLV, 734-739.

The problem of dosage in temporary sterilization is discussed from the physical standpoint. The author shows, for instance, that changes in position may lead to considerable inaccuracies if measurements are carried out during irradiation by placing the chamber in the vagina. With proper technique the total error of determining the dose effective in the ovaries will not exceed  $\pm 5$  per cent. From the standpoint of dosimetry, therefore, no objections can be raised to temporary sterilization.

ERNST A. POHLE, M.D., Ph.D.

Preliminary Experience with the Protracted Fractional Dose Method. G. Herrnhäuser. *Strahlentherapie*, 1933, XLVI, 435.

This is a brief report of the author's experience with 48 patients treated according to the Coutard method. He usually gives 75 r per minute filtered through 2 mm Zn or 1.2 mm Cu, the daily dose being from 300 to 400 r, the total dose 4,200 to 4,800 r per field. The method was tried only in advanced cases: in 22 the tumor definitely decreased in size, in 14 there was a partial response, and in 12 no effect could be seen. Although his experience is not large, the author considers the method as promising in suitable cases.

ERNST A. POHLE, M.D., Ph.D.

## EXPERIMENTAL STUDIES

Roentgenologic Demonstrations of the Human Brain in a Living Subject. Berlin letter in *Jour. Am. Med. Assn.* May 27, 1933, C, 1707.

In the *Klinische Wochenschrift*, A. Radovici and O. Veller report on a new method for the roentgenologic demonstration of the human brain in the living subject. They experimented with methods of demonstrating in roentgenograms the plastic relief of the central nervous system by obscuration of the spinal fluid with the aid of a contrast medium. For this purpose they injected a colloidal solution of thorium dioxide into the spinal canal or into the brain first into the dead bodies of new-born infants and later into dogs, rabbits and apes. The sulci between the convolutions of the brain appear as black narrow stripes, whereas the convolutions stand out in relief. The spinal cord itself appears to be limited by two black parallel bands which correspond to the shadow-producing spinal fluid. Since, after from one to two months, the relief outlines of the central nervous system have become much paler and the dark stripes appear only as fine lines, it may be assumed that the injected substance is gradually absorbed and disappears from the surface of the

brain The animals treated in this manner do not behave differently from the controls The authors believe, therefore, that the favorable results justify the use of this or similar technic on man The use of thorium salts for a demonstration of other organs has been known for several years

C G SUTHERLAND, M D

## FOREIGN BODIES

Foreign Body in Mediastinum, Esophagoscopic Removal under Roentgenoscopic Guidance Herman J Moersch and B R Kirklin Jour Am Med Assn, Jan 21 1933, C, 169, 170

In this case a new endoscopic experience in the treatment and removal of a foreign body, lying entirely in the mediastinum, is reported A girl, aged 3 years, began to suffer from dysphagia two months previous to admission The dysphagia gradually progressed, failing to respond to various types of medical treatment Roentgen examination revealed a foreign body at the level of the arch of the aorta and presumably in the esophagus A week previous to admission mediastinitis and pneumonia developed Roentgenoscopic examination showed the foreign body to be outside the lumen of the esophagus and this was confirmed by esophagoscopic examination The child was permitted to return home and was brought back 25 days later She was in poor condition and much dehydrated Roentgenographic examination showed that the inflammatory reaction had subsided After surgical consultation it was decided to attempt removal by the esophagoscopic approach Under roentgenoscopic control the foreign body (a small lead horse with a rider) was broken into pieces and removed The rider dropped into the esophagus and was allowed to pass naturally Immediately following the esophagoscopy a temperature of 104° F developed The temperature returned to normal on the next day and the child was able to take liquids without difficulty The patient gained five pounds in weight in the first week and has had no further difficulty

C G SUTHERLAND M D

Open Safety Pin in the Stomach of a Two-months old Baby Harry Otten Jour Am Med Assn, March 11 1933 C 736

A baby girl aged 2 months swallowed an open safety pin The roentgenogram and roentgenoscopic examination for each of six successive days showed the safety pin in the cardiac end of the stomach in the same position as when swallowed Bread potato, and cooked cereals were given in addition to regular nursing After six days surgical intervention was decided upon An abdominal incision was made the pin was closed by manipulation through the stomach wall a stomach tube was passed and the closed safety pin was manipulated

into the stomach tube and withdrawn without difficulty

C G SUTHERLAND, M D

Foreign Body in the Duodenum Report of Case and Method of Removal Sidney W Raymond Jour Am Med Assn Feb 4, 1933, C, 337

A case report of an infant aged 14 months who swallowed a "bobby pin" A roentgenogram showed the pin lying in the fundus of the stomach The child was placed on a diet consisting mainly of vegetables and citrus fruit pulp Subsequent roentgenographic studies showed the pin lodged in the second portion of the duodenum, where it remained for 52 days before consent was received for surgical intervention Previous to operating, a pin of the same kind and size was found to slide with moderate ease into the side opening of a No 20(F) catheter Under ether anesthesia, an upper right rectus incision was made The pin was milked into the stomach and through the thin wall of the stomach was easily placed point-first inside the catheter (presumably passed by mouth, though not stated) the same as in the practice test, and brought out through the mouth Recovery was uneventful

C G SUTHERLAND M D

## GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Internal Fistulas of the Biliary Tract R Prevot Röntgenpraxis, March, 1933 V, 177-182

About forty cases of roentgenologically diagnosed internal fistula of the biliary tract have been reported in the literature Such fistulas are possible between the biliary tract and the gastro-intestinal canal between parts of the biliary tract itself the biliary tract and the venous system, and finally the thorax by communication of a liver abscess with a bronchus of the right lung The cause for spontaneous fistulas is usually chronic inflammatory disease of the biliary tract with or without stones less often perforating ulcers of the stomach and duodenum Most of the cases reported in the roentgenologic literature are gall bladder duodenal fistulas Only four fistulas between gall bladder and colon have been reported The clinical symptoms might be typical—that is symptoms of an acute perforation with temperature chills etc—or might be very slight The roentgenologic diagnosis is usually not difficult air in the gall bladder on the flat film barium in the biliary tract after a colon enema or barium meal are pathognomonic Usually the mucosa of the stomach or duodenum or colon is markedly hypertrophic and distorted in the region of the fistula Occasionally one may demonstrate gallstone in the lumen of the bowel which are responsible for intestinal obstruction

H W HERRI M D

Radiologic Exploration of the Appendix Silvijs Kadrnka and R Sarasin Jour Am Med Assn, Oct. 1, 1932, XCIX, 1183, 1184

The authors have an article in *Presse medicale*, illustrated with roentgenograms. Some workers have administered, with the contrast medium, stimulants of intestinal contraction. Kadrnka and Sarasin first give the patient castor oil and then apply a lavage of the large intestine with water. The barium enema is given with the patient in the Trendelenburg position, the distention of the cecum being controlled under the fluoroscope. After evacuation of the opaque enema, air is injected under fluoroscopic control. The image of the cecum is represented by the outline of the thin layer of barium which remains adherent to the cecal mucosa. The appendix is frankly visible. Non-visibility of the appendix justifies suspicion of the existence of important lesions. Of 24 cases presenting an invisible appendix 16 were operated on and all showed lesions.

C G SUTHERLAND MD

Ectopy of the Cecum Clinical and Radiologic Gastro-duodenal Syndrome of Subhepatic Appendicitis M Santoro Archivio di radiologia, 1932 VIII 355-371

The author describes two cases of anomalous position of the cecum and appendix inflammation producing the clinical and radiologic symptoms of ulcerating lesions in the stomach and duodenum. The symptoms in the stomach and duodenum were probably due in part to adhesions and partly to reflex phenomena. The author shows the importance of x-ray examination of gastro-intestinal lesions especially to bring out anomalous positions of the viscera and emphasizes the necessity of appreciating morphologic changes in the various organs which are always brought out by a careful and thorough examination.

F T LEDDY MD

Roentgen Studies of Patients with Gastrointestinal Food Allergy Albert H Rowe Jour Am Med Assn Feb 11 1933 C 394-400

Four patients with marked and prolonged gastric symptoms which had been relieved by the elimination of specific foods were selected. Careful physical examinations and laboratory studies had ruled out other causes. The re-introduction of the same foods in the diets had reproduced the symptoms on more than one occasion in each patient. Roentgen observations consisted of fluoroscopic examinations and roentgenograms made immediately on the ingestion of barium and 3, 10 and 24 hours thereafter. Such studies were first made when the patients had been free from their symptoms for several weeks.

About two or three weeks after this initial study a second series of observations was made after the patients had taken milk or milk and egg for one or two days. The barium was also administered in malted milk, to which each patient was sensitive. Marked disturbances in muscular tone and motility resulting from probable allergic reactions in the gastro-intestinal tissues were observed in each of the patients.

C G SUTHERLAND MD

Cystic Myoma of the Ileum, with Intestinal Hemorrhage George G Finney Jour Am Med Assn Feb 11 1933 C, 408-410

This is a case report of a patient with no other history of import than persistent blood in the stools. Fluoroscopic examination showed a large prolapsed stomach, very active and contracting vigorously. The pyloric end was deformed as the result of operative intervention. No actual deformity was seen. Films showed a 'cow-horn type' of stomach hypertonic, with good motility, and spastic. A defect in the duodenal cap suggested ulcer. There was slight retention at the end of 24 hours. Proctoscopic examination did not show anything abnormal. Abdominal exploration revealed a mass the size of an orange in the region of the sigmoid flexure. At a later date a second operation was performed and this mass was resected. Microscopically it was shown to be a cyst wall made up of flattened, rather broad strands of a dense connective tissue. The final diagnosis was myoma of the ileum with cystic degeneration and hemorrhage.

C G SUTHERLAND MD

Duodenocolic Fistula with Incompetent Sphincter of Oddi Clarence E. Rees Jour Am Med Assn Feb 18 1933, C, 496

This is a case report of a fistula between the duodenum and the colon not secondary to a malignant growth. Traction from the fistulous tract had resulted in incompetence of the sphincter of Oddi, so that the contents of the duodenum was allowed to pass into the bile passages. The liver had suffered no apparent damage in spite of the fact that it had been subjected to regurgitation of the contents of the duodenum and the colon over a long period. Roentgen examination of the gastro-intestinal tract showed partial filling of the common bile duct with barium and distribution of the barium throughout the ramifications of a portion of the hepatic ducts. Post-operative roentgen examination demonstrated that duodenal contents was still regurgitating into the bile ducts apparently because of incompetence of the sphincter of Oddi.

C G SUTHERLAND, MD

## HEART AND VASCULAR SYSTEM

Coarctation of the Aorta, with Report of Three Cases G F Strong Can Med Assn Jour, July, 1932, XXII, 15-19

The occurrence in the author's practice of three cases of this rare disease within the period of a little over a year makes this series of case reports interesting

The first case was that of a gardener aged 18, who had been ill for two weeks, the diagnosis being rheumatic aortic valvular endocarditis. He made an apparently good recovery and resumed his usual occupation. Sixteen months later he suddenly collapsed while skating and was dead before arriving at the hospital to which he was being taken. At autopsy the pericardial sac was found to be distended with blood from a tear in the dilated and thinned ascending aorta, proximal to a narrow constriction.

The second case was that of a carpenter, aged 38 following an attack of cardiac decompensation after an illness of two years. At autopsy there was found an extreme constriction of the aorta 2 cm distal to the origin of the left subclavian artery. X-ray films of the chest showed enlargement of the heart density at the right base and irregular erosions along the lower margin of the upper ribs.

The third case was that of a school girl, aged 12, who died of renal failure following an attack of scarlet fever. At autopsy there was found a chronic nephritis, and the aorta showed a coarctation in the descending portion of the arch.

The author makes the comment that, while the diagnosis of coarctation was not made in any of these three cases during life, yet the possibility of this condition should be borne in mind when dealing with cardiac and aortic conditions.

L J CARTER, M D

Status and Clinical Application of Roentgenology of the Thoracic Aorta. John Sproull Am Jour Roentgenol and Rad. Ther July 1932 XXIII, 37

X-ray examination is an essential in the diagnosis of aortic disease, for with such study aortic pathology, not discoverable by other methods of examination, may be demonstrated and the study is also valuable in helping to exclude aortic disease as the cause of intrathoracic symptoms. Clinical diagnosis by methods not including x-rays is attended by a considerable diagnostic error, especially in syphilitic aortitis. Reid found an error of 44 per cent in 78 autopsy cases. There are many conditions including angina pectoris, paroxysmal dyspnea, unexplained cough, unusual pulsations, aortic valve disease, and others which should have the benefit of roentgen examination of the great vessel. Among the reasons why cardiovascular x-ray studies are not more frequently made are: (1) many roentgenologists are not familiar with the technique of the ex-

amination nor of the normal and pathologic anatomy and are therefore, unable to give the clinician the essential degree of co-operation, (2) many practitioners feel able to diagnose aortic disease without x-ray assistance, (3) the value of x-ray study is not well known to the profession in general or to the laity. It is important to remember that the Wassermann may be negative in from 15 to 40 per cent of cases of syphilitic aortitis. Both the arteriosclerotic and syphilitic forms of aortitis are fairly common diseases hence the frequent need of roentgen methods to supplement the clinical findings and the Wassermann test.

J E HARRIS, M D

A New Sign of Pericardial Effusion. Eli Moschowitz. Jour Am Med Assn May 27, 1933 C 1663, 1664

There are three signs usually conclusive in determining the diagnosis of pericardial effusion: (1) widening of the area of cardiac flatness, (2) abrupt transition from pulmonary resonance to cardiac flatness, and (3) widening of the cardiac dullness in the second intercostal space. No one of these signs taken singly, is conclusive, but together they form a triad which is thoroughly reliable, as confirmed by roentgen examination or at autopsy. The widening of the cardiac outline in the second intercostal space is merely another evidence that pericardial effusions have a pronounced tendency to accumulate at the base of the pericardial sac. This widening is confirmatory of one of the important diagnostic criteria of pericardial effusions in roentgen diagnosis, namely, the increased widening of the cardiac shadow at the apex of the cardiac triangle.

C G SUTHERLAND, M D

Roentgenographic Studies of the Right Ventricle. G Nemet and J B Schwedel. Am Heart Jour June 1932 XII 560-573

By means of barium placed in the interventricular grooves of isolated human hearts, the exact location of this groove was determined for the various roentgenographic projections. Particularly in the left anterior oblique position the site of the interventricular groove was verified as being consistent with a groove on the left lower contour frequently seen in fluoroscopy.

Studies made of the inflow and outflow tracts of the right ventricle are also described. The first demonstrable changes occurring in right ventricular enlargement being those of the outflow tract that they are represented roentgenologically by a prominence in the region of the pulmonary conus in the posterior anterior projection. A displacement of the interventricular groove to the left and upward and a prominence of the ventral border of the heart below the angulation are observed in the left anterior oblique when the inflow tract of the right ventricle is enlarged.

ALMA FOX, M D



## THE JOINTS

Chondromalacia of the Patella Fissural Cartilage Degeneration Traumatic Chondropathy Report of 3 Cases Jacob Kulowski Jour Am. Med Assn, June 10, 1933, C 1837-1440

Chondromalacia of the patella is characterized by a circumscribed primary degenerative fibrillation, fissuring, and erosion of its articular surface. It occurs as a solitary lesion or may be associated with other common causes of internal derangement of the knee joint. In either event, it has been shown to be a definite clinical entity. Pathologically, it is a localized form of arthritis deformans (so-called hypertrophic type). First clinically recognized by Budinger in 1906 and again in 1908, who called it "fissures of the patellar cartilage." The more appropriate term "chondromalacia" originated with König in 1926.

Chondromalacia of the patella usually occurs in the young. The history is one of chronic disability with general symptoms of internal derangement of the knee joint. Pain as a rule, is referable to the patella or to its immediate vicinity. The intermittent hydrops attending exertion is due to the inevitable secondary synovial sequelæ. Characteristically there is localized patellar pressure-tenderness in acute flexion. The roentgenogram reveals little of definite value even when the ulceration is markedly advanced but is strongly suggestive when slight hypertrophic changes are noted about the joint in addition to these signs and symptoms. Roentgen examination is however absolutely essential for a differential diagnosis. An exact diagnosis can be made only when the patella is adequately exposed surgically.

Trauma must be assigned as the primary activating force on a background of constitutional predisposition, the poor regenerative power of the cartilage, and the peculiar mechanism of the knee joint.

CHARLES G. SUTHERLAND M.D.

Regeneration of the Distal Phalanx L. H. McKim Can. Med. Assn. Jour. May 1932 XXVI 549-550

It has been known for many years that the distal phalanx is able to regenerate following the removal of the diaphysis for osteomyelitis which has not involved the proximal or epiphyseal portion of the bone or the interphalangeal joint. The number of cases in which amputation is performed following osteomyelitis of this bone leads one to suspect that this ability to regenerate has either been forgotten by many of us or that it has not been sufficiently emphasized.

The author presents a case report from the Montreal General Hospital. Following an osteomyelitis of the distal phalanx of the right middle finger an

x-ray film showed that sequestration of the shaft had occurred but that the interphalangeal joint was intact. At operation the diaphysis was removed but the epiphysis was untouched. Subsequently the bone regenerated, as shown by a series of x-ray films.

L. J. CARTER, M.D.

Contribution to the Hereditary Factors in Multiple Cartilaginous Exostoses Heinz Kirchhoff Röntgenpraxis, June, 1932 IV, 383-387

It is generally known that multiple cartilaginous exostoses are frequently found in different members of the same family. A family tree is reproduced, the examination of which shows that there is only direct transmission. Healthy members do not transmit a predisposition to cartilaginous exostoses or enchondromas. It seems necessary to collect more such family trees as only a comparatively small number of them has been published.

H. W. HEFKE M.D.

Examination of the Elbows of Tennis Players W. Knoll Schweiz. med. Wchnschr. July 1932, LXII 640-643

The author conducted radiographic examinations of the elbows of various participants in the International Tennis Tournament in Germany. Although all but one of the patients examined had been actively engaged in tennis playing for more than five years the demonstrable changes were negligible. The few pathologic changes that were demonstrated had an adequate traumatic background. Thirteen of the players had played in various matches for over ten years and no bone changes were demonstrated in any of them. The author concludes that the so-called tennis elbow is a rare manifestation.

H. C. OCHSNER M.D.

## THE MASTOID

The Early Recognition of Otitic Intracranial Complications V. V. Wood Laryngoscope May, 1932, XLII 335-355

This extensive and important subject is considered under the following heads: (1) Physical examination, (2) Temperature curve, (3) Bacteriologic study of the secretions from the middle ear and mastoid, (4) Lumbar puncture, (5) Blood picture, (6) X-ray examinations.

While Dr. Wood does not add any new points to x-ray interpretation he ably reviews the subject. He stresses the importance not only of x-ray examination of the mastoids but also of using the x-ray as a means of differential diagnosis from other conditions with similar temperature curve and blood

picture. He specifically mentions pulmonary conditions in this connection.

The rather detailed discussion of mastoid interpretation brings out or emphasizes the following (1) It is not always possible to differentiate old and new pathology, and passive processes may be misinterpreted as active ones (2) Films may not show mastoiditis until several days after definite clinical manifestations (3) Occasionally the x-ray findings are exaggerated (4) Serial films are frequently helpful in making a diagnosis (5) As healing occurs there is an increasing thickening of the "mucosa and intracellular contents." This fibrosis and sclerosis cause an increased opacity on the films that must be differentiated from a progress of the original infection.

On the whole, the author seems to have a sound understanding of the necessity, value, and difficulty of x-ray examination of mastoids.

HILLYER RUDISILL, JR. M.D.

The Roentgen Demonstration of Petrositis. Milton J. Geyman and Daniel M. Clark. *Acta Radiol.* 1932 XIII, Fasc 2, 125-133.

Suppuration in the petrous portion of the temporal bone is frequently recognized by present-day otologists. It is characterized by suppurative otitis media, temporo-parietal pain, abducens paresis and low-grade fever (Gradenigo's syndrome). Three groups of cases occur: (1) those arising during the course of an acute otitis media with little or no mastoid involvement, (2) those occurring during an acute mastoiditis and (3) the type appearing as a post-operative sequel two or three weeks after mastoidectomy. In those cases falling under Groups I and II, prompt opening of the mastoid is indicated. In the third group, Profant advocates conservative treatment with frequent paracentesis. Many of this type will recover without further surgery. When conservative measures fail, exenteration of the cells in the petrous tip often effects a cure.

Positions used in the study of the petrous portion of the temporal bone for eighth nerve tumors are not satisfactory when applied to the demonstration of petrositis. The most consistently useful positions are the vertex-mental and fronto-occipital, both of which are described and illustrated.

The changes occurring in petrositis are similar to those found in mastoiditis. An early involvement will show simply a haziness of cell outline and displacement of air. Later on destructive changes are seen and finally healing with sclerosis throughout the involved area. Ordinarily a roentgen diagnosis of petrositis is not justified in the absence of clinical symptoms. It is generally agreed that the condition occurs only in the pneumatized petrous and when sclerotic pyramids are demonstrated on both sides the likelihood of infection is remote.

D. M. CLARK, M.D.

## EFFECT ON OFFSPRING

Comparative Histology of the Ovaries in its Relation to the Question of Injury of the Offspring Caused by Roentgen Rays. Rudolt Dyroff. *Strahlentherapie* 1932, XLV 711-733.

The author emphasizes the fact that nearly all experiments dealing with the production of mutations by irradiation were done by exposing the male gonads. He feels that the results so obtained cannot be accepted for the case in which the female gonads are exposed. The biologic difference between the two organs is too great for one to expect the same mutations in both cases. In the author's opinion there is no proof furnished as yet that temporary sterilization is injurious to the future offspring, provided it is carried out under the proper precautions.

ERNEST A. POHLE, M.D. Ph.D.

The Genetic Foundations of Roentgen Mutations. Paula Hertwig. *Strahlentherapie*, 1932, XLV, 657-678.

Temporary Sterilization by Irradiation and Human Genetics. Hans Luxenburger. *Strahlentherapie*, 1932 XLV, 679-690.

The first article is a critical review of the experimental data accumulated so far as to the effect of roentgen rays and radium on mutations in plants and animals. The author comes to the conclusion that changes in the genes may occur following irradiation. It is probable that the majority of these changes are undesirable. No figures can be given as to the changes to be expected in human beings. However, the mere possibility of an injury to the offspring is sufficient to warn against that danger. Luxenburger emphasizes the last conclusion and defends the resolution warning against temporary sterilization (see article by Wintz, *Strahlentherapie*, 1932, XLV, 653-656).

ERNEST A. POHLE, M.D. Ph.D.

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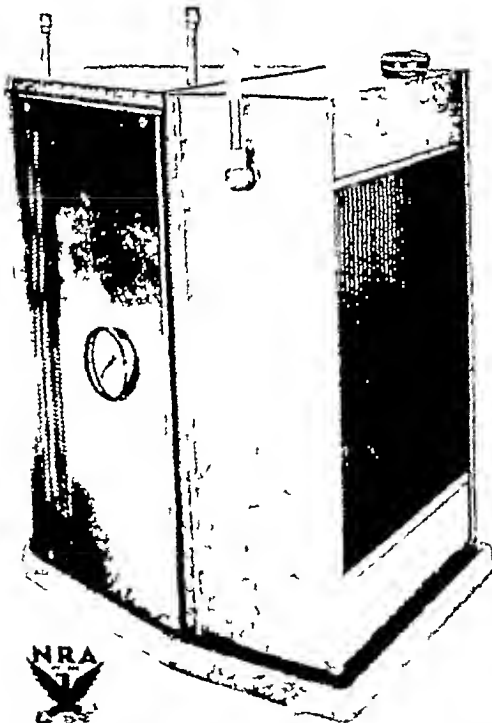
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picture. He specifically mentions pulmonary conditions in this connection.

The rather detailed discussion of mastoid interpretation brings out or emphasizes the following: (1) It is not always possible to differentiate old and new pathology, and passive processes may be misinterpreted as active ones. (2) Films may not show mastoiditis until several days after definite clinical manifestations. (3) Occasionally the x-ray findings are exaggerated. (4) Serial films are frequently helpful in making a diagnosis. (5) As healing occurs there is an increasing thickening of the "mucosa and intracellular contents." This fibrosis and sclerosis cause an increased opacity on the films that must be differentiated from a progress of the original infection.

On the whole, the author seems to have a sound understanding of the necessity, value, and difficulty of x-ray examination of mastoids.

HILLYER RUDISILL, JR., M.D.

The Roentgen Demonstration of Petrositis. Milton J. Geyman and Daniel M. Clark. *Acta Radiol.* 1932, XIII, Fasc. 2, 125-133.

Suppuration in the petrous portion of the temporal bone is frequently recognized by present-day otologists. It is characterized by suppurative otitis media, temporo-parietal pain, abducens paresis, and low-grade fever (Gradenigo's syndrome). Three groups of cases occur: (1) those arising during the course of an acute otitis media with little or no mastoid involvement, (2) those occurring during an acute mastoiditis, and (3) the type appearing as a post-operative sequel two or three weeks after mastoidectomy. In those cases falling under Groups I and II prompt opening of the mastoid is indicated. In the third group Profant advocates conservative treatment with frequent paracentesis. Many of this type will recover without further surgery. When conservative measures fail exenteration of the cells in the petrous tip often effects a cure.

Positions used in the study of the petrous portion of the temporal bone for eighth nerve tumors are not satisfactory when applied to the demonstration of petrositis. The most consistently useful positions are the vertico-mental and fronto-occipital, both of which are described and illustrated.

The changes occurring in petrositis are similar to those found in mastoiditis. An early involvement will show simply a haziness of cell outline and displacement of air. Later on destructive changes are seen and finally healing with sclerosis throughout the involved area. Ordinarily a roentgen diagnosis of petrositis is not justified in the absence of clinical symptoms. It is generally agreed that the condition occurs only in the pneumatized petrous and when sclerotic pyramids are demonstrated on both sides the likelihood of infection is remote.

D. M. CLARK, M.D.

## EFFECT ON OFFSPRING

Comparative Histology of the Ovaries in its Relation to the Question of Injury of the Offspring Caused by Roentgen Rays. Rudolf Dyroff. *Strahlentherapie*, 1932, XLV, 711-733.

The author emphasizes the fact that nearly all experiments dealing with the production of mutations by irradiation were done by exposing the male gonads. He feels that the results so obtained cannot be accepted for the case in which the female gonads are exposed. The biologic difference between the two organs is too great for one to expect the same mutations in both cases. In the author's opinion there is no proof furnished as yet that temporary sterilization is injurious to the future offspring provided it is carried out under the proper precautions.

ERNST A. POHLE, M.D., Ph.D.

The Genetic Foundations of Roentgen Mutations. Paula Hertwig. *Strahlentherapie*, 1932, XLV, 657-678.

Temporary Sterilization by Irradiation and Human Genetics. Hans Luxenburger. *Strahlentherapie*, 1932, XLV, 679-690.

The first article is a critical review of the experimental data accumulated so far as to the effect of roentgen rays and radium on mutations in plants and animals. The author comes to the conclusion that changes in the genes may occur following irradiation. It is probable that the majority of these changes are undesirable. No figures can be given as to the changes to be expected in human beings. However, the mere possibility of an injury to the offspring is sufficient to warn against that danger.

Luxenburger emphasizes the last conclusion and defends the resolution warning against temporary sterilization (see article by Wintz, *Strahlentherapie*, 1932, XLV, 653-656).

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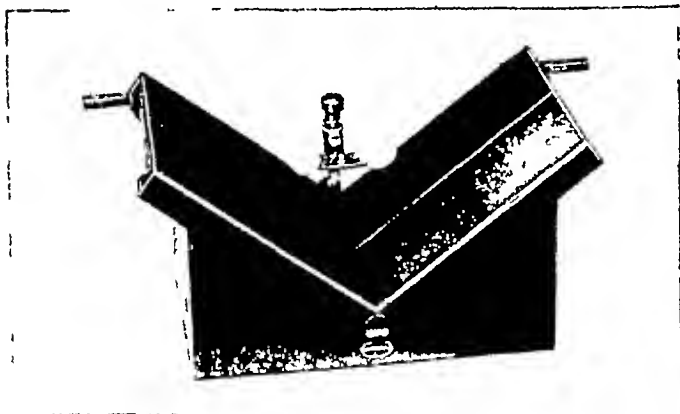
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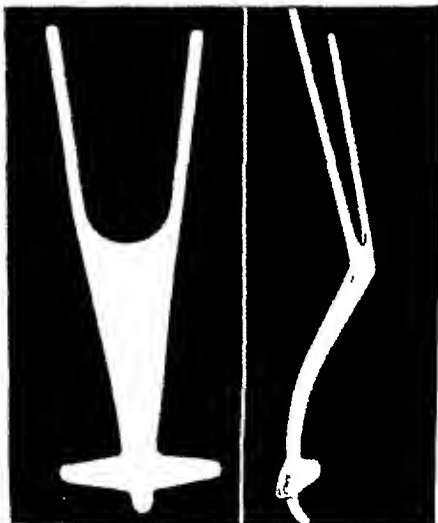
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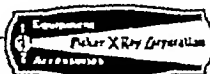
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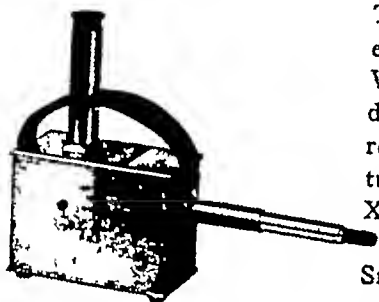
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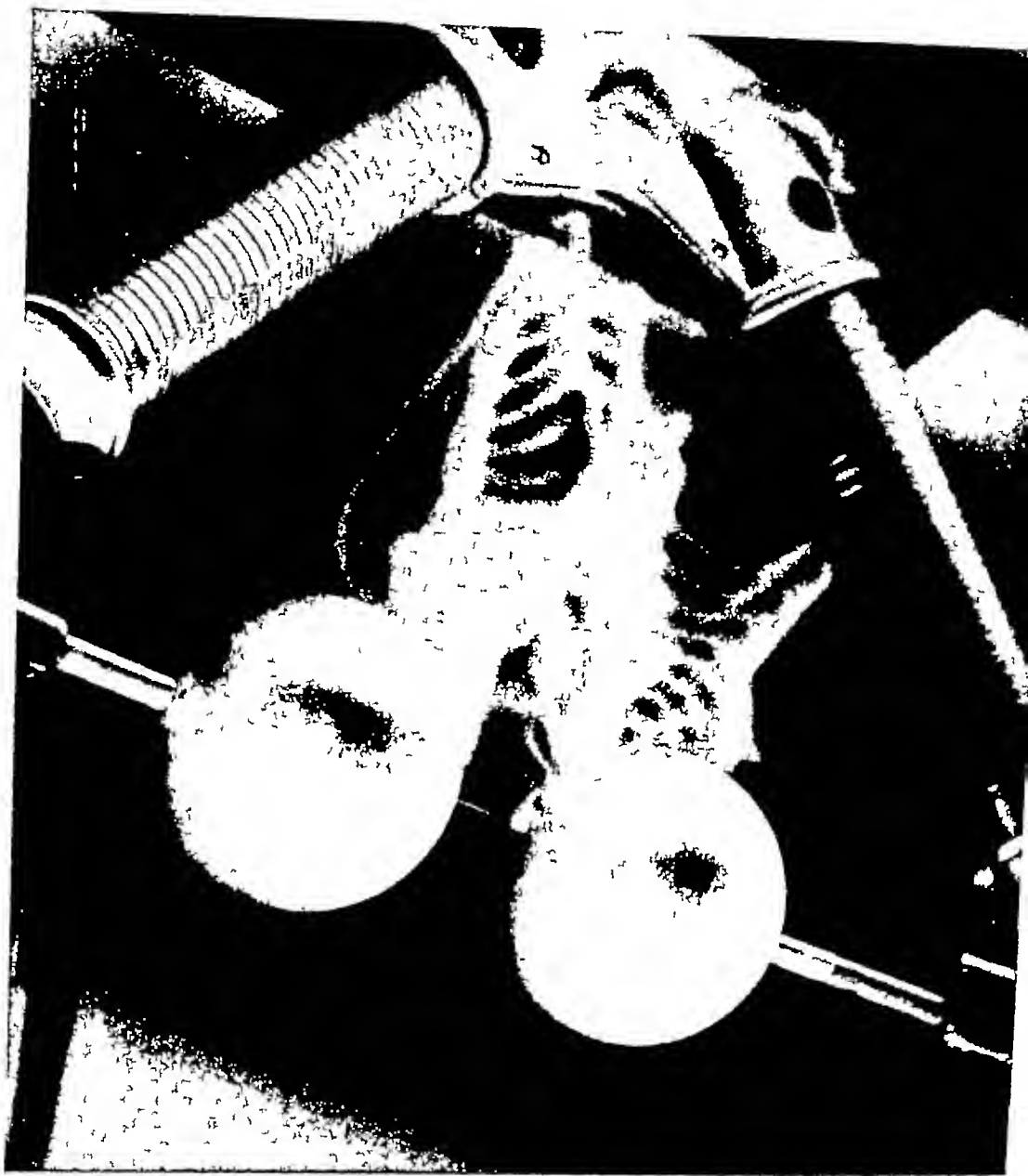
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OCTOBER, 1933

Volume XXI

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# RADIOLOGY

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VOL XXI

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No 4

## THE EFFECT OF RADIATION TECHNIC AND THE EARLY DIAGNOSIS OF CARCINOMA OF THE UTERINE CERVIX ON THE FIVE-YEAR GOOD END-RESULTS'

A STUDY BASED ON 488 PRIMARY CASES

By HENRY SCHMITZ MD FACS FACR, CHICAGO  
Professor of Gynecology Lovola University School of Medicine

THE radiological and surgical methods of treatment of carcinomas of the uterine cervix have been technically so perfected that further improvement in the five-year good end-results, commonly called cures may probably not be expected. The absolute curability percentages, reported from different clinics, vary from 20 to 25 per cent, while the relative curability percentages of the clearly localized carcinomas vary from 75 to 90 per cent. If the patients came for treatment during the early stage then the control of cancer would be achieved.

Therefore, a study of five-year good end-results obtained in 488 primary carcinomas of the cervix was made (1) to investigate the influence of radiation technic on the end-results and (2) to discuss the possibilities of very early diagnosis. These studies are herewith reported.

In 1928<sup>1</sup> the writer reported the five-year good end-results obtained with the technic of combined radium and roentgentherapy in 332 cases of primary carcinomas of the uterine cervix. It was shown that the per-

centage of absolute cures increased with the progress of development of roentgentherapy, and, therefore, an increase in the total roentgen dose. The radium dose, 50 mg radium element filtered with 2 mm brass and 3 mm para rubber, has remained the same, namely from 4,500 to 4,800 mg radium element hours, though the continuous application of the dose in one sitting was changed to a 12-hour daily interval method, and, finally, to an 8-day interval method, giving one-third of the dose at each sitting. A study of the relative end-results of each Clinical Group showed that, in the clearly localized growth of Clinical Group 1 they amounted to 78.27 per cent cures.

Since 1923 another change in technic has been made. A water-cooled Coolidge treatment tube was installed, permitting activation of the tube with from 25 to 30 ma at from 200 to 225 kilovolts. The application of the roentgen radiation dose was distributed to five sances every third day, applying one-fifth of the calculated dose to each field at each sitting. The total radiation dose to each field was 1,200 r without back-scattering.

The number of fields and the total roentgen dose were calculated from the size of the patient. An attempt was made to

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting in St. Louis, Nov. 30, Dec. 4, 1931.

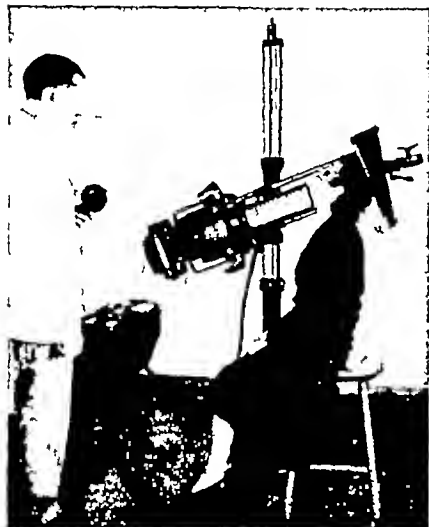
SCHMITZ HENRY and HUEPER WILLIAM. The Prognostic Value of the Histologic Malignancy Index and the Clinical Grouping of Carcinoma of the Uterine Cervix. *Radiology* Volume 12, No. 3, 1931.

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TABLE II

Clinical Group	1914 1919					1920 and 1921					1922 and 1923					1924 1927				
	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
	5	16	70	35	132	9	13	26	29	77	9	19	50	36	123	12	14	61	69	156
Total number admitted																				
Total 5 year good end results	5	7	7	0	19	6	6	2	0	14	7	7	11	0	25	10	6	16	3	35
Percentage 5 year good end results	100	43 75	9 21	0	14 30	66 67	46 75	7 69	0	18 38	77 78	38 64	18 65	0	20 32	83 0	42 85	26 23	4 35	22 43

Grand Total 1914-1927

Clinical Group	1	2	3	4	Total
Total number admitted	35	62	222	169	488
Total 5 year good end results	28	26	36	3	93
Percentage 5 year good end results	80 0	41 94	16 36	1 72	19 14

facts of general importance should be mentioned

1 Cancer does not start in healthy tissues or organs

2 Cancer begins in a spot or focus the cells of which at first are not malignant

3 Chronic irritation causes this spot, or works on this nodule, producing the changes characteristic for malignancy

4 All tumors must grow to some extent before causing symptoms

5 The discovery of cancer during the symptomless period would put us in control of the disease

6 If the physician became "cancer-minded," *i.e.*, would learn always to think of the possibility of the presence of a malignant disease in chronic tissue changes, then diagnosis would be rendered without delay

7 The avoidable delay, caused by the physician in placing the patient under observation instead of insisting on an immediate diagnosis and immediate treatment, is responsible for the poor end-results of treatment.

The diagnosis of carcinoma should include (1) The macroscopic appearance, (2) the histologic structure, (3) the extent of growth development, (4) the symptoms. It is obvious that each one of these characteristics undergoes an orderly sequence in development from the beginning to the terminal stages. An intimate knowledge of these factors is a prerequisite to early diagnosis.

#### THE MACROSCOPIC FINDINGS

The macroscopic picture of cancer varies depending on the type of growth, whether it is endophytic or exophytic. The sequence of changes in the endophytic type are nodule, ulceration, necrosis, and, finally, sloughing with crater formation. In the exophytic type, the changes are nodule, papilloma, cauliflower growth with necrosis and, finally, sloughing with crater formation.

TABLE I  
FACTORS USED IN ROENTGEN TREATMENT FOR EACH PERIOD TO SHOW PROGRESS  
IN DEVELOPMENT OF TECHNIC

Periods	1914-1919	1920, 1921	1922, 1923	Since 1924
Transformer	Snook Cross arm Type		Cross arm Type to deliver 300 K V	
Type of Tube	Standard Coolidge Treatment with broad focus		200 K V air cooled Coolidge	250 K V water cooled Coolidge
Peak Kilovoltage	110	140	211	211
Filter Copper plus Aluminum	6 mm Al	0.5 mm Cu plus 1 mm Al	1 mm Cu plus 1 mm Al	0.75 mm Cu plus 1 mm Al
Focus-skin Distance	25 cm	65 cm	65 cm	65 cm
Size of Fields	25 sq cm	225 sq cm	225 to 400 sq cm	225 to 400 sq cm
Number of Fields	8 to 20	2 to 5	2 to 5	2 to 5
Dose to Each Field	150 ma -min	1,050 ma min	1,000 ma -min	1,250 ma min
Interval	8 to 20 days One field daily	One hour daily 8 to 15 days	One field daily 2 to 5 days	5 x 250 ma min Every third day to each field
Depth Dose at 10 cm	About 20 per cent	About 35 per cent	48 per cent	44 per cent
Units in r			800 without back-scatter	1,200 without back scatter

attain a roentgen dose of two threshold erythema doses at the cervix. Table I gives the factors used in the roentgentherapy for each of the four periods. Table II gives the five-year good end-results for each period, the relative cures for each Clinical Group in each period, and a summation of all the cases treated from 1914 to 1927.

I shall not dwell on the influence of the radiation dose in the arrest of carcinoma. Those interested are referred to the reports in the literature.<sup>3,4</sup>

The perusal of Table II brings out two facts:

1 The better curative end-results obtained with an increase in the roentgen dose, as the radium dose has been the same during the entire series.

2 The high percentage of cures attained

in the localized, *i. e.*, Clinical Group 1, carcinomas.

It is evident that the percentage of cures varies inversely with the development or extent of the growth. The relative curability in the beginning, clearly localized Clinical Group 1 cancers is from 75 to 90 per cent, in the doubtfully localized Clinical Group 2 cancers, from 35 to 50 per cent, in the Clinical Group 3 cases, involving the parametrium, when the mass retains a fair degree of mobility, from 10 to 25 per cent, and in the terminal fixed carcinomas *i. e.*, Clinical Group 4 cases, it is practically zero.

Clinical Group 1 carcinomas are incipient cancers which are clearly limited to the cervix and, as a rule, have not yet caused symptoms. They are also internal cancers which the patient is not able to see or feel as is the case in skin or breast tumors. It is therefore obvious that the physician must attempt to discover them.

Before discussing early diagnosis several

<sup>3</sup>SCHMIDT, HENRY. *Technic in Pelvic Irradiation*. *Radiology*, December 1931, XVII, 1230-1242.

<sup>4</sup>SCHMIDT, HENRY. *The Value of Short Wave Roentgen Rays and Radium in Carcinomas of the Uterine Cervix*. Read before the American Association for the Advancement of Science, Pasadena, Calif., June 15-20, 1931.

staining qualities, irregularity in the shape and size of the cells and the nuclei, and loss of polarity. Beneath the basal membrane, and in contact with this new epithelium, is an acute inflammatory exudate.

In the next step of development the round cells may break through the basal layer in places, coming in actual contact with the most recently produced epithelial cells. The basal layer has failed in its protective function.

These atypic or anaplastic changes present the earliest evidence of the incidence of cancer in the human subject. This, according to Bailey and Schiller, is the moment of change from benign to malignant—the cancer phase. What proceeds thereafter does so in spite of any additional external factors which thenceforward are present. It is, in itself, progressive and inevitable.

Microscopic examinations of tissues removed by biopsy or by amputation of the cervix require serial sections to find evidences of cellular atypia or anaplasia, otherwise it would be impossible to find very early carcinomas. They also preclude the treatment of suspicious looking chronic cervicitides with the electric cautery, as the method might destroy such beginning cancerous foci. Therefore, we are more and more inclined not to use the cautery but to employ minor surgical procedures to obtain tissue for microscopic examination. Thereby one is placed in a position to rule out malignancy.

#### THE EXTENT OF THE TUMOR

The extent or growth development is determined by a general physical examination and a special pelvic examination. The latter comprises inspection by speculum and endoscopes, bimanual vagino-abdominal and recto-abdominal palpation, instrumental palpation with sound or curette and eventually x-ray diagnostic procedures. The location and size of the growth, the condition of the parametria and adjacent organs (vagina,

bladder, and rectum), invasion of the regional lymph nodes, and distant metastases are ascertained by these methods.

The following questions should be answered:

1 *Is the cancer clearly localized?* Such a beginning nodule should have a diameter of about one centimeter and should be clearly limited and freely movable within the cervix. The entire uterus possesses normal consistency, elasticity, and mobility.

2 *Does doubt exist of the absolute localization?* Such a tumor may have already spread to one-half of the cervical wall. It is surrounded by an area of inflammatory reaction enclosing dendritic processes of carcinomatous tissue. The area is reddened, edematous, or of doughy consistency. Mobility of the uterus is impeded, due to loss of elasticity of tissue, especially of the paracervical connective tissue.

3 *Are the parametrium or regional lymph nodes involved, and are the invaded structures mobile or fixed?*

4 *Have metastases or extensions occurred to the bladder, vagina, and rectum?*

5 *Has distant metastasis taken place?*

The answers to these five questions permit of a clinical grouping as follows: Group 1, the clearly localized growth; Group 2, the doubtfully localized growth; Group 3, the invasive growth in which the invaded parametrium or lymph nodes are movable; and Group 4, the disseminated and fixed growth including (a) the frozen pelvis, (b) invasion of bladder, vagina or rectum, and (c) distant metastases.

Inflammatory infiltration may complicate a uterine carcinoma. Nodular infiltration means carcinoma especially if the uterine tissue is continuous with the parametrial masses and the uterus is not displaced laterally, anteriorly, posteriorly, or superiorly. Fixation of the uterus occurs late in carcinoma and early in parametritis. It abates in the latter when resolution takes place.

As benign nodules are more frequently seen than malignant ones, the cancer nodule is recognized with difficulty. It cannot be diagnosed by inspection or palpation. It does not cause symptoms. The Chrobak-Clark sign may be presumptive. If bright red blood appears when a nodule is touched with a dull-pointed object, and the arterial bleeding continues for some time, then one may presume that cancer is probably present. But a positive diagnosis rests on an immediate diagnostic excision of the nodule within the surrounding healthy tissue and an immediate frozen section diagnosis. Procrastination by observation must never be practised.

The beginning ulcer and papilloma are also difficult to diagnose because ulcers and papillomas are more frequently benign than malignant. The ulcer results from the peculiar tendency of the central carcinoma cells to degenerate, due to the poor blood supply. The papilloma tends to grow outward, but here, also, the central cells degenerate and become friable early. Such small ulcers and papillomas bleed when touched. "Contact bleeding" is the first symptom of cancerous tumors. A diagnostic excision should be made within the healthy tissues followed by an immediate frozen section diagnosis to rule out malignancy.

Necrosis is manifested by friability of tissue. The growth has the consistency of brain substance. On withdrawal the examining finger may bring out sufficient material for microscopic examination to corroborate the clinical diagnosis. The periphery of such tumors which is indurated and nodular clearly invades the adjacent tissues. Arrosion of blood vessels causes spontaneous hemorrhages while necrosis produces discharge.

Cancer formation with irregular and indurated walls, is in evidence of the extensive sloughing of the necrotic and friable tumor particles. It is indicative of an advanced stage and is almost invariably asso-

ciated with wide dissemination into and fixation of tumor to the pelvic fasciæ and bones. Pain is added to the symptoms of hemorrhage and discharge and it always signifies an invasion by the cancer of the deeper pelvic structures or the adjacent organs.

When cancer arises in sites not easily accessible to microbes, it is a chronic disease and may not destroy the patient's life for many years. Cancer in protected sites often grows silently and unsuspectedly, but when it is easily accessible to putrefactive bacteria, for example, in the alimentary or genital tracts, the primary lesion is readily colonized. Such sequences soon manifest themselves and may speedily destroy the patient. The virulence of cancer, as a rule, depends not alone on the malignant character but also on its septicity. Putrefactive microbes are the common cause of failure in attempts to relieve cancerous patients by gross surgical and radiologic methods.

#### THE MICROSCOPIC CHARACTERISTICS

The histologic characteristics of a carcinoma are

- 1 The atypia or anaplasia of the epithelial cells
- 2 The invasion or breaking through of the basement membrane
- 3 The destructive tendencies in displacing or assimilating normal tissues and cells
- 4 The formation of metastases, either by continuity into the adjacent tissues and organs, or by emboli in the regional lymph nodes or distant sites

The microscopic diagnosis does not depend on the presence of all these factors. A diagnosis of cancer is justifiable without evidence of metastasis, it is valid without presence of destruction and it is warranted in the absence of invasive tendencies. Early carcinoma is present when atypia or anaplasia alone are seen. The latter is characterized by blurring of the cell mass, down growth of the epithelium with preservation of the basal layer, abnormal behavior in

tion in diagnosis to the general practitioner in his clinic, so that he may be taught to recognize a pathologic cervix. If the practitioner is well trained in diagnosis he may institute necessary procedures. If he cannot make the diagnosis, he should know that immediate, expert consultation should be had. Delay for the purpose of observation is an error, if carcinoma must be ruled out. If the beginning stage of cancer were not devoid of symptoms, then the outlook for better end-results of treatment would be encouraging. A cancer causing symptoms has very often passed the stage of curability.

#### CONCLUSIONS

1 The influence of the radiation dose on the five-year cures has been discussed briefly. It has been shown that an increase in the dose, due to perfection in technic, has given better permanent end-results.

2 It is doubtful if the absolute percentage of five-year cures can be improved by the present methods of treatment. Since the relative curability of clearly localized, *i.e.*, beginning, cancers is about 80 per cent, and as the early stage is free from symptoms the patient cannot be aware of the onset of the cancer. The physician must discover such beginning stages by requesting routine yearly examinations following labor, abortion, and puerperium. When making a first health examination, he should subject every female patient to inspection and palpation and insist on a yearly re-examination thereafter.

3 The macroscopic, microscopic, growth and symptom characteristics have been discussed and graded. Thereby it is hoped to facilitate very early diagnosis of cervical cancers.

#### DISCUSSION

DR I. R. SANTI (St. Louis). It is with some timidity that I attempt to discuss Dr Schmitz's paper, for he has had wide experience for a long period of time. It is rather gratifying to the radiologist, however, to see

the increasingly good results that are attained by him over these various year-periods with the increase in the penetrability of the x-rays used. You know, it seems surprising, but there are to-day large cancer clinics in which x-rays are not used in conjunction with radium treatment. Yet they attempt to evaluate their treatment with radium alone as against the use of radium and x-rays.

Dr Schmitz's high percentage of cures should be convincing and could hardly be compared to any other method of treatment, surgery included, it seems to me. I think his statistics are quite convincing and I hope they are given widespread publicity among the medical profession.

His high percentage of ultimate cures by radium and x-rays in cases in Groups 2 and 3 that do not come up for consideration at all as surgical risks compares more favorably than the best figures with the surgical method of treatment. Yet we still have to-day from isolated services papers indicating the superiority of operative procedure in carcinoma of the cervix. Oftentimes these statistics are based on inaccurate estimates of results of radiation with radium, without associated x-ray therapy.

It is high time, it seems to me, that the truth concerning the use of radiation be made known and such statistics as Dr Schmitz has shown should obtain the widest publicity in the entire medical profession.

DR ROBERT E. FRICKE (Rochester, Minn.). Dr Schmitz's five-year results show what can be accomplished by scientific, thorough, painstaking work. His classification is excellent and is based on good anatomic grounds.

I think the one point on which we often differ in statistics is in the classification. Conditions that some of us would call Stage 2 would be called Stage 3 by others, and so forth. I want to call your attention to an important publication which came out in 1929,<sup>1</sup> in which Heyman, of Stockholm, Regaud, of Paris, and Doderlein, of Germany, worked out their five-year results, describing them fully.

<sup>1</sup>Cancer Commission. Reports submitted by the Radiological Subcommission. Geneva. Series of League of Nations Publications. 3 Health 1929. 3-5. 82 pages.

Co-existing tumors, such as ovarian cysts and uterine myomas, may cause displacement of the uterus and impede its mobility, though the carcinoma may be in the initial stage

#### SYMPTOMATOLOGY

The sequence of symptoms depends on the extent of the growth. The clearly localized nodular growth is free from symptoms, the doubtfully localized beginning ulcer and papilloma cause "contact bleeding", the invasive, necrotizing carcinoma is accompanied by hemorrhage and discharge, and the crater-shaped, fixed carcinoma produces hemorrhage, discharge, and pain. Hemorrhage is the earliest and most alarming symptom, discharge the most repulsive and constant, and pain the most unfavorable symptom of cancer. A carcinoma causing pain is as a rule hopeless and incurable.

To the characteristic primary symptoms should be added the secondary or accessory symptoms resulting from invasion of adjacent organs, from compression of neighboring structures, from toxemia due to the septicity of the cancer, and from the cachexia occurring in all chronic and wasting diseases. Thus invasion of the bladder causes dysuria, pollakiuria, hematuria, pyuria. Invasion of the rectum produces tenesmus, discharge, bleeding, ribbon-like stools. Compression of the ureters ter-

minates in hydronephrosis with eventual pyonephrosis, with deep, constant, unbearable pain in the side affected. Septic infection is accompanied by pyrexia, putrid discharge, malaise, and so forth, while cachexia is characterized by an extensive catabolism, with rapid loss of weight and strength. Accessory symptoms are always suggestive of an advanced state of cancer and signify a poor prognosis.

It may be concluded from Table III that the beginning nodule, the initial focus of carcinoma from which the disease progressively and inevitably develops, shows, on microscopic examination, a cellular atypia of the epithelium, as yet devoid of invasion, destruction, and metastasis. The nodule is clearly limited and the uterus retains normal mobility. The growth has not thus far caused symptoms. These findings characterize the earliest stage of carcinoma. The diagnosis must be made by biopsy.

How may one find the symptomless, clearly localized, and nodular stage of carcinoma of the cervix? The profession should educate women to report for periodic health surveys after infection, labor, and abortion, and yearly thereafter. If symptoms of leukorrhea, menorrhagia, or irregular bleeding occur, the patient should apply immediately for an examination. The duty rests on the gynecologist, the teacher of gynecologic diagnosis, to provide facilities for instruc-

TABLE III—CORRELATION OF THE HISTOLOGIC AND CLINICAL SIGNS

Group	Macroscopic Appearance	Histologic Development	Grouping of the Extent of the Growth	Symptoms
1	Nodule	Cellular atypia	Clearly localized growth Normal mobility of uterus	None
2	Ulcer or papilloma	Invasion of basement membrane	Doubtfully localized Impeded mobility of uterus	Contact bleeding
3	Large ulcer or cauliflower growth with necrosis	Destructive tendencies	Invasion of parametrium or regional lymph nodes. Entire tumor mass mobile	Hemorrhage, discharge
4	Crater	Metastasis local or distant	1 Frozen pelvis with absolute fixation of tumor 2 Local dissemination to vagina, bladder, or rectum 3 Distant metastases	Hemorrhage, discharge, pain



to learn, there had not been a single permanent recovery. He added "I have performed my last amputation for sarcoma of the long bones." Only a few years later one of the most distinguished professors of pathology in America told me that if he personally had ever had a sarcoma of a long bone he should have an immediate amputation performed regardless of the histologic type of the tumor. Here we have two widely divergent views regarding the best method of treating sarcoma of the long bones. In further proof of this I would cite Crile (3), whose recent study of 7390 cases of malignancy (of which 160 were bone sarcoma) has led him to the following conclusion: "It is still uncertain whether a primary malignancy of bone should be treated by x-ray or by surgery, but two things are certain—first, if an operation is performed, it should be preceded and followed by x-ray radiation, and second, if the condition is in a limb, amputation should immediately follow radiation, provided the condition is not inoperable." On the other hand, Forssell (4) doubts whether irradiation prior to or after amputation is of any use. Personally I have always been strongly opposed to pre-operative irradiation for sarcoma of the long bones and up to the present time there is little evidence to prove post-operative irradiation is of value.

Nor is a study of the recent literature on the subject very helpful. During the past five years four important books on bone sarcoma have been published: two in France and two in the United States.<sup>2</sup> With the exception of that by Geschickter and Copeland based on a study of the large amount of material at Johns Hopkins Hospital these books afford the surgeon little help in choos-

ing the best method of treatment of sarcoma of the long bones.

Twenty years ago the percentage of five-year recoveries following amputation alone varied from 2 to 4 per cent. With increasing ability to interpret the roentgenologic features of the early stages of bone sarcoma, it became possible to make a diagnosis much earlier than was formerly the case. In other words, an earlier recognition of the disease permitted an earlier amputation. This, I believe, explains the improved results reported in the more or less recent statistics, including those of Meyerding and Gask to which I have already referred. Lacking a knowledge of these results, and basing their opinions on the statistics of more than twenty years ago, many surgeons still maintain a pessimistic attitude toward amputation in the treatment of sarcoma of the long bones. This has resulted in a growing trend toward irradiation for all types of bone sarcoma. At the present time I believe the majority of osteogenic sarcomas are being treated by irradiation.

In trying to choose between two or more methods of treating a serious condition that involves not only the limb but the life of the patient, the first essential is a fairly definite idea of the results obtained in a large series of cases treated by various methods. No such rule has been observed in the drift toward irradiation because until recently the essential data for making this choice were lacking. In the great majority of cases I doubt if either the surgeon who refers the patient to the radiologist or the radiologist himself has any clear idea of the end-results obtained in a large series of sarcomas of the long bones treated by irradiation, and without such knowledge I cannot see how either can give an opinion of much value. The recently published statistics of the Memorial Hospital<sup>3</sup> covering more than two hundred cases of operable malignant sar-

<sup>2</sup>Nove Jo. erand G. and Tavernier L. *Tumeurs Malignes de l'Os*. Cat. Doin & Cie. Paris 1927.

Sabraz J. Jeanneney G. and Mathey Cornat R. *Les Tumeurs de l'Os*. Masson et Cie. Paris 1932.

Geschickter C. F. and Copeland M. M. *Tumors of Bone*. Am Jour. Cancer 1931.

Kelly V. *Bone Sarcoma*. Surg. Gynec. and Obst. Vol. 12, 2. Part II.

<sup>3</sup>Ann. Surg. March 1933.

according to the anatomic classification. They described their Stages 1, 2, 3, and 4 much as Dr. Schmitz has, but, nevertheless, I think that all radiologists in gynecologic work should have this report at hand.

At the Mayo Clinic, Dr. Bowing and I have the report on our desks at all times and try to transpose our cases into the correct stage according to the classification. It is helpful to have a common standard of classification to which all of our cases in any locality may be made to conform.

DR. SCHMITZ (closing). The points I wish to bring out are

1 The significance of chronic cervicitis as a precursor of carcinoma

2 Cancer must have existed for some time before it causes symptoms

3 Routine health inventories, especially of women who have had infections or gone through abortions and labors, to discover pathology, notably nodules or papillomas

4 If the physician interprets the pathologic cervix correctly and institutes indicated treatment without delay and before symptoms arise, cancer of the cervix will be put under control. Statistics prove that cases treated during this stage show from 75 to 90 per cent permanent cures.

## RESULTS OF IRRADIATION IN THE TREATMENT OF OPERABLE OSTEOGENIC SARCOMA OF THE LONG BONES<sup>1</sup>

By WILLIAM B. COLEY, M.D., NEW YORK

From the Department of Bone Sarcoma, Memorial Hospital and Hospital for Ruptured and Crippled, New York

UP to 1923 the results following surgical treatment of periosteal or subperiosteal sarcoma, now classified as osteogenic sarcoma, were bad, one reason for this being that the diagnosis was not often made until the disease had reached such an advanced stage that there remained little hope of saving the life of the patient by amputation or other form of treatment. In a review of the statistics of various European clinics, mostly in England and Germany, Butlin (1) found only one three-year recovery in 68 cases of periosteal sarcoma of the femur treated by hip joint or high amputation, and not a single recovery in sarcoma of the humerus. Little improvement in results was noticed until 1920. In 1922, Meyerding (2), of the Mayo Clinic, reported 15 five-year recoveries in a series of 100 cases of sarcoma of the long bones exclusive of giant-cell tumors, treated by amputation. In many of these cases, amputa-

tion was followed by prophylactic treatment with Coley's toxins, and in a number, by irradiation of the chest. An improvement in results was noticed in the European clinics also. In May, 1923, at a Symposium on Bone Sarcoma by the Association of Surgeons of Great Britain and Ireland, held in London, Gask reported 57 cases of sarcoma of the long bones, exclusive of giant-cell tumors that had been admitted to St. Thomas' Hospital during the period from 1901 to 1921. In 46 cases amputation was performed, 12 patients were alive three years later, 7 were well for more than five years, and one died of metastasis to the skull almost seven years after amputation.

These are exceptionally good results and yet, when Meyerding read his paper at the meeting of the American College of Surgeons in 1922, Besky, of Chicago, who took part in the discussion, stated that he had amputated the limb for sarcoma of various types in 20 cases at the Cook County Hospital and that as far as he had been able

<sup>1</sup>Read before the Radiological Society of North America, at the Eighteenth Annual Meeting at Atlantic City, New Jersey, Dec. 1, 1932.

in this field to make a correct diagnosis, even in the early stages of the disease. In fact, if we wait until the tumor has developed sufficiently for anyone to make a positive diagnosis, we have waited too long, in many instances, to save the life of the patient. Those who have had a large experience in this field know that in certain cases the growth of the tumor is very rapid, a series of roentgenograms taken at various intervals will often show the tumor to have doubled in size in the course of three weeks. This being so, I can see no advantage in running the risk of the disease becoming generalized during the period of irradiation when there is no corresponding advantage to be gained. If the entire tumor, with the limb or the major part of it, is to be removed, why is it not more rational and more logical to remove it as early as possible without waiting a month for irradiation and running the risk of metastases developing? While these may be regarded as theoretic grounds for objecting to pre-operative irradiation, we have far more convincing practical grounds which I shall present.

I repeat that I do not think we are ever justified in waiting four weeks to make a positive diagnosis of osteogenic sarcoma of the long bones. I have had patients who have died within three months of the first appearance of the tumor, and others who have developed extensive pulmonary metastases within two weeks following high voltage x-ray treatment. For example, the following case:

Case 1. A McK., female, aged 17 years, was admitted to the Memorial Hospital on October 29, 1923. One year previously she had fallen and injured her right knee. In August, 1923, there was increasing pain and swelling of the knee. The clinical diagnosis on admission was that of periosteal sarcoma of the lower end of the femur. From November 2 to November 9, 1923, she had three exposures to x-rays, 15 minutes each. On November 1 she developed a temperature of

102°, this subsided but rose to 101° on November 23, to 103° on November 24, and to 104° on November 25. Symptoms developed which were regarded as pneumonia with pleurisy. On aspirating, several ounces of bloody fluid were evacuated. Roentgenograms taken on December 9, 1923, showed evidence of extensive pulmonary metastasis. Another cycle of roentgentherapy was given from January 3 to January 14, 1924 (four exposures, 60 minutes each). The disease ran a rapid course and proved fatal on February 8, 1924, a little over three months after the patient's admission to the hospital.

If a positive diagnosis cannot be made from a study of the clinical and roentgenologic evidence, then a biopsy should be performed by the surgeon who has been selected to take charge of the future treatment of the case.

Contrary to the opinion of Bloodgood and Dean Lewis, I should never amputate a limb on the strength of a diagnosis made from a frozen section alone. If the tumor contains new bone, as so many osteogenic sarcomas do, then it is impossible to make an accurate diagnosis from a study of the frozen section, one must wait for decalcification of the specimen to take place. I have never seen any bad result from the short delay incident to preparing paraffin sections. According to John B. Murphy, "The surgeon who depends upon frozen sections for a diagnosis in bone tumors of central origin will come to grief."

The cases in which there has been the greatest difficulty in diagnosis and the greatest difference of opinion, both as to the type of tumor and the treatment to be employed, in my experience, have been those involving the upper end of the humerus in children and in young adults. I recall four such cases.

*Treatment*—The first point to be considered is, whether or not pre-operative irradiation shall be employed.

Pfahler and Parry (6) claim in a paper entitled "Treatment of Osteogenic Sarcoma

coma of the long bones treated by primary irradiation (x-rays or radium), I believe furnish sufficient data from which to formulate an opinion as to the relative value of irradiation and amputation in this condition, and it is the purpose of this paper to review these statistics especially as regards osteogenic sarcoma.

In 1916, shortly after the Department of Bone Sarcoma was organized at the Memorial Hospital, we began a study of the question of the value of irradiation in the treatment of bone tumors, including both the malignant osteogenic and the benign giant-cell types. We had at our command an adequate amount of radium as well as the most approved high and low voltage x-ray equipment. The late Dr. Janeway, Dr. Quick, and, since 1921, Dr. Herendeen, Dr. Duffy and Dr. Bradley L. Coley, have been all greatly interested in the problem. Realizing that the results of amputation were far from ideal—although steadily improving with our increasing ability to make an earlier diagnosis—we were willing to give irradiation a fair and prolonged trial. Even if we did not succeed in curing more cases by irradiation than had recovered after amputation, we hoped that a later amputation, after failure to control the disease by irradiation, might show a higher percentage of five-year recoveries.

After a careful analysis of our results in 1928 we were forced to conclude that the opinion expressed by Janeway, as well as by Pinch, of London, that osteogenic sarcoma is too highly resistant to irradiation to justify the latter's employment in these cases was correct. This opinion was apparently reached by Ewing also who, at the International Cancer Congress in London in 1928 stated:

When the signs point to a true osteogenic sarcoma of medullary and subperiosteal sclerosing or telangiectatic type, the best treatment is probably immediate amputation preceded if necessary by a biopsy at the same

time. With these cases, radiation seems to have accomplished very little."

Owing to certain patients' refusal to submit to an amputation we have continued to use irradiation in a considerable number of cases of operable osteogenic sarcoma observed since 1928, but this increased experience has not caused us to alter our opinion. We still believe that the best method of treating osteogenic sarcoma of the long bones is amputation (without pre-operative irradiation) as soon as the diagnosis is established, with, most important of all, a prolonged course of Coley's toxins as a prophylactic measure, after amputation. I have long advocated this in all of our cases as a routine.

As regards a brief preliminary course (one month) of irradiation before amputation, meanwhile submitting the roentgenograms to a number of radiologists for the purpose of establishing the diagnosis, as advised by some, I would say that I cannot commend this practice. Consultations are usually of value in all difficult cases—and there are few fields in medicine or surgery in which an early diagnosis is more difficult than in bone sarcoma—but a multiplicity of opinions is not always in advantage. Bloodgood (5) tells of a surgical colleague who submitted the roentgenograms of a bone tumor to sixteen consultants and received sixteen different opinions. He recalls another who submitted his case to eight consultants, all agreed on an amputation without biopsy, which was performed—the condition proved to be osteomyelitis of the Garre non-suppurative type.

While a few cases can always be cited in which it has been found extremely difficult to make a diagnosis not only from the clinical and roentgenologic evidence but even with the aid of the microscope these should be recognized as exceptions. In the majority of cases of bone sarcoma it is possible for anyone who has had considerable experience

perienced radiologists Bloodgood himself states

"I have specimens of three limbs in the laboratory in which a bone was the seat of a benign cyst, and prolonged deep x-ray therapy had so destroyed the soft parts or necrosed the bone that amputation was necessary. There are, in addition, five examples of giant-cell tumor in which the introduction of radium into the bone shell after curetting was associated with an osteomyelitis which resulted ultimately in producing great deformity and loss of function or making amputation necessary. These preventable results from irradiation have not all been in the hands of inexperienced radiologists."

A considerable number of similar results have been observed at the Memorial Hospital, and I believe this number would be still further increased if we were to adopt the practice of treating "every bone lesion which in the x-ray is suspicious of malignancy, with a thorough and complete course of irradiation."

Next what is meant by "a thorough and complete course of irradiation"? It certainly means more than the brief period of three or four weeks while waiting to make a diagnosis as suggested by Bloodgood in 1931. One is led to believe that he would continue irradiation as long as there was any evidence of improvement. Apparently both the contemplated biopsy and the possible amputation are to be postponed indefinitely. This procedure I believe to be a bad one and if generally followed will almost certainly result in the loss of many lives which otherwise might have been saved by early amputation without preliminary—especially without prolonged—irradiation.

I do not think the danger of prolonged irradiation in osteogenic sarcoma can be too strongly emphasized. I recall two cases of osteogenic sarcoma in which the diagnosis was made in the early stages and in both of which irradiation was advised by Bloodgood. The first was a sarcoma of the tibia

in a girl who, before coming to me, had received four months' intensive irradiation without apparent effect in controlling the growth of the tumor or in alleviating pain. Although I performed an immediate amputation, following this with prolonged toxin treatment, the patient developed metastases and died within six months. The second patient was a young man with a sarcoma of the lower end of the femur that had developed shortly after a severe local trauma. A correct and early diagnosis of osteogenic sarcoma had been made from the clinical and roentgenologic evidence alone. Irradiation was advised. The pain was promptly relieved, and marked improvement was noticed in the local condition. On these grounds it was deemed wiser to continue the irradiation instead of performing an amputation at the end of a few weeks. The treatment was kept up for nearly a year, at the end of which time the patient was told he could resume his work. Shortly thereafter, he was referred to our clinic. While there was scarcely any noticeable enlargement of the femur, it was thought best to perform a biopsy. This was done and the tumor proved to be an osteogenic sarcoma. An immediate amputation was performed by Dr. Bradley L. Coley, followed by prophylactic toxin treatment. In spite of this, the patient developed metastases to the clavicle and other bones within three months, and later to the lungs and died within six months.

In both of these cases I believe the chances of saving the patient's life would have been greater had an early amputation been performed without preliminary prolonged irradiation. A third case, admitted to the Hospital for Ruptured and Crippled in 1930, still further supports this opinion. A male adult whose family history was negative complained of pain and swelling in the mid-femur over a period of nine months. He had been admitted to one of the best hospitals of New York where a correct diag-

by Means of Irradiation" that preliminary irradiation of bone tumors for three or four weeks, followed by amputation, has given them the best results to date. They add "Based on Holfelder's observations, it would seem that we may not have waited long enough for the full beneficial effects of irradiation." They advocate a biopsy but only after one month of irradiation by deep roentgen therapy. An analysis of the 57 cases reported therein shows only six sarcomas of the long bones well for a period of five years or more, four of which were treated by amputation in addition to irradiation, and one by excision. The only one treated without surgery had no microscopic confirmation of the diagnosis. Therefore, their results were not obtained "by means of irradiation" alone but by irradiation plus surgery.

While the results of Pfahler and Parry are markedly better than those obtained at the Memorial Hospital by prolonged irradiation, they are no better than, if as good as, those reported by Meyerding, of the Mayo Clinic, and Gask, of St. Thomas' Hospital, London, who employed early amputation without irradiation. In spite of this Pfahler and Parry, and Holfelder (7) of the Roentgen Institute of the Surgical University Clinic, Frankfurt, who is so frequently quoted by Pfahler, agree that irradiation is superior to surgery, and believe it is now the method of choice in the treatment of osteogenic sarcoma. Holfelder advocates prolonged irradiation instead of amputation. In analyzing his series we find that it consists of only 25 cases, nearly one-third of which were giant-cell tumors, and of which only 16 were traced for more than three years. In three of the six classified as clinical cures there was no histologic confirmation of the diagnosis. Therefore, I regard Holfelder's series as much too small and the period of observation too brief to be of any value in making a comparative study of ir-

radiation and amputation in the treatment of osteogenic sarcoma.

There is one difficult question that has scarcely been touched upon by the advocates of pre-operative irradiation for sarcoma of the long bones, and that is, in the event of marked improvement (and there are many such cases in our own experience), are we to stop at the end of a month's time even if the tumor is much smaller? Apparently most would continue irradiation as long as improvement is observed. Unfortunately our experience at the Memorial Hospital has shown that those osteogenic sarcomas that have responded to such an extent as almost to warrant regarding them as endothelial myelomas, after a few months have suddenly developed metastases to the lungs and other bones. Then, at this late date, amputation has yielded bad results much worse than has early amputation.

While Bloodgood (5), in 1931, saw no objection to a brief course of irradiation for three or four weeks prior to a biopsy or an amputation, one year later (8) he took a much stronger stand in favor of pre-operative irradiation, as will be seen by the following quotation:

"The deep x-ray therapy is available all over the country so there is no difficulty in giving the patient the benefit of a full trial while the diagnostic survey and consultation are going on. I repeat and emphasize that with our knowledge as it is to day it is distinctly better to begin the treatment of every bone lesion which in the x-ray is suspicious of malignancy, with a thorough and complete course of irradiation."

Let us examine for a moment Bloodgood's argument. While it is true that the deep x-ray therapy is available all over the country, it is only fair to point out that but comparatively few radiologists have had a large experience in the treatment of bone sarcoma. A considerable number of serious results from over irradiation of bone tumors have occurred even in the hands of ex-

firmation of the diagnosis, and in the opinion of Dr Ewing, the condition might well be one of myositis ossificans. The other case, registered by Evans and Leucutia, was an inoperable sarcoma of the ilium of the osteogenic type. It was classified as an osteogenic sarcoma by the Registry Committee but the fact that it was called a "round-cell" tumor with apparently no new bone formation, makes it possible to consider a diagnosis of endothelial myeloma, or Ewing's sarcoma.

The present Bone Sarcoma Registry of the American College of Surgeons was founded by Dr E A Codman in 1920. It was the hope of the founder, as well as of those interested in this field, that a careful study and analysis of this vast collection of material, including the clinical, roentgenologic, and microscopic data, would lead to clearer understanding of the various types of bone sarcoma, and would prove an invaluable aid in the selection of the best method of treatment, thus bringing about an improvement in the almost hopeless prognosis of osteogenic sarcoma. That this hope has not been fulfilled has been demonstrated on several occasions, most strikingly, in my opinion, by the exhaustive study of the Bone Registry cases made by Kolodny (9), in 1927, and by the more recent, brief report of Bartlett (10). In his chapter on the treatment of osteogenic sarcoma (p 107) Kolodny states:

"In bone sarcoma as in other malignant tumors the question of the therapy is still awaiting its answer. It is a strange fact that with our knowledge of minute details of the histopathology of bone tumors the progress along the practical therapeutic road is almost in the same stage that it was in some fifty years ago. As a rule, malignant bone tumors are fatal and we know of no therapeutic method to prevent death from this disease."

Three years later Bartlett, in analyzing 125 registered cases which had been followed for five years after the first treatment



Fig 2 Same case as shown in Figure 1 after three months irradiation

found 11 cases of endothelial myeloma and 31 of osteogenic sarcoma that were classified as five-year cures. Of the 31 osteogenic sarcomas, 29 were of the long bones. Amputation was performed in all but one case. This, Bartlett has classified as "fibro (?) sarcoma (atypical)" treated by exploration, excision, toxins, and radium. As this happened to be one of my own cases, a few comments may be permitted. In the first place, only an exploratory biopsy was performed, there was no excision—merely a small piece of tissue was removed for microscopic examination. The tumor involved



Fig 1 Osteogenic sarcoma of tibia treated with x-rays for three months no improvement Amputation by Dr B L. Coley July 20 1927 Pulmonary metastasis death

nosis of osteogenic sarcoma had been made from the clinical and roentgenologic evidence supported by a biopsy. High voltage roentgen therapy was given over a period of eight months. The tumor gradually increased in size and the pain persisted, in addition the biopsy wound remained unhealed. When I first saw the patient he had a tumor involving two-thirds of the shaft of the femur and extending so high up that a hip-joint amputation was impossible. A large fungating mass occupied the whole anterior surface of the thigh from which exuded a sanguino-purulent discharge. The patient had had several small hemorrhages which

had increased in frequency and severity. He received nothing but palliative treatment while under my care, and died within a few weeks. The lesson to be learned from this case is most important. An autopsy was performed which failed to reveal evidence of metastases in any other part of the body. In other words, had an amputation been performed at an early date or even before the condition had become inoperable, it is almost certain that the patient would have been alive to-day.

I mention these cases to show how widely prevalent has become the practice of turning cases of osteogenic sarcoma of the long bones over to the radiologist for treatment. Hitherto there was a reasonable excuse for this practice inasmuch as there were no published statistics on the results of irradiation in a large series of osteogenic sarcoma.

It may be argued that improvement in the technic of administering radium and roentgen ray may lead to better results. Granting this, I believe there will always be a sufficient number of cases of osteogenic sarcoma that refuse amputation or in which amputation is contra-indicated for various reasons, to furnish ample material for further research with irradiation, but I do not believe we are any longer justified in substituting irradiation for amputation in the early operable osteogenic sarcomas of the long bones thereby depriving the patient of a considerable chance of a permanent cure.

That this opinion is based upon more than a personal experience is shown by the following case. A short time ago I wrote to Dr B C Crowell the Registrar of the Bone Sarcoma Registry of the American College of Surgeons asking him how many of the registered osteogenic sarcomas treated by irradiation had remained well for five years or more. His reply was that there were two, only one of which was a sarcoma of a long bone. It was associated with a football injury. There had been no microscopic con-



nancy, and all were well from five to twenty-eight years after amputation. With results such as these, I cannot understand how Bartlett can make the following statement:

"We have learned to allow our patients who are suffering with malignant bone disease to die whole under the comforting and pain-relieving effects of x-ray and morphine, and we have learned to carefully preserve the limbs affected with non-malignant disease, thus saving their owners from a life of mutilation, deformity, and disability."

I do not believe that a large number of limbs have been amputated for supposed malignant sarcoma, which later proved to be the site of a benign lesion. Personally, I have never had such a case.

Such a statement as the one quoted above, if accepted, cannot but do great harm in dissuading patients from submitting to an amputation which if followed by post-operative treatment by Coley's toxins, offers a considerable chance, at least 30 per cent, of saving their lives. Bartlett's list of 31 five-year recoveries from osteogenic sarcoma by no means represents the entire number of "cured osteogenic sarcomas of the long bones" in the Bone Sarcoma Registry, since it includes only six cases registered under my name and omits ten additional five-year recoveries of osteogenic sarcoma of our Memorial Hospital series that had already been registered below the last serial number mentioned in Bartlett's list. Our entire list of five-year cures of sarcoma of the long bones contains 33 cases of osteogenic sarcoma and 25 cases of endothelial myeloma.

Inasmuch as the following case (Reg. No. 183) for a long time was the only registered osteogenic sarcoma in which the limb was saved and the only osteogenic sarcoma with metastases that had been cured by any method of treatment, a brief history may be of interest.

*Case 2. Periosteal osteogenic sarcoma involving one half of the shaft of the tibia with extensive metastases to the groin and iliac*

*fossa. Treated by Coley's toxins and irradiation, limb saved, patient well more than fifteen years later.*—C. H. S., male, aged 39 years, was referred to me by Dr. John H. Gibbon, of Philadelphia, in the latter part of April, 1917, with a history of a rapidly growing tumor of the shaft of the left tibia of six weeks' duration. It was regarded by Dr. Gibbon and several other surgeons as a periosteal sarcoma. While I agreed with this diagnosis, yet in order to have it confirmed microscopically, I removed a small piece of the tumor and submitted it to Dr. Ewing, who pronounced it a highly malignant osteogenic sarcoma. In an attempt to save the limb, the following conservative measures were adopted. Injections of Coley's toxins were given in conjunction with irradiation (the radium pack, 46,720 millicurie-hours, was applied over the tibia from May 1 to July 19). The toxins were resumed at home by the patient's family physician, Dr. R. G. Gamble, of Philadelphia. In the middle of August, the patient asked permission to go to the seashore for a month and as physical examination at this time showed no evidence of the disease remaining, it was thought safe to discontinue the treatment for a few weeks. On his return in the early part of October, examination showed extensive metastases in the inguinal, femoral, and iliac glands, some of which were an inch or more in diameter. Notwithstanding the hopeless prognosis, I decided to give the patient a further trial of treatment. The radium pack was applied over the glands of the groin in October (18,000 mc-hrs.) in November (17,270 mc-hrs.) and in December (12,000 mc-hrs.). At the same time the toxins were resumed and kept up with occasional intervals of rest for two and a half years, in doses not sufficient to interfere with the patient's routine of life. All evidence of the disease disappeared and the patient is alive with a useful limb at the present time sixteen years later.

The result obtained in this case illustrates the importance of continuing the treatment over a long period of time.

*Case 3. Osteogenic sarcoma (No. 100, Bone Registry) of the lower end of the femur treated with prolonged irradiation (radium)*

nearly one-half of the tibia. Amputation had been advised by almost all who had seen the case. A positive diagnosis of typical periosteal osteogenic sarcoma was made by Twing, and the diagnosis of the Committee of the Bone Sarcoma Registry was that of osteogenic sarcoma. An unusual feature of this case was the presence of extensive metastases in the inguinal, iliac, and femoral glands (diagnosis confirmed microscopically). Under Coley's toxins and irradiation (radium pack) the patient made a complete recovery, and is in excellent health, with a useful limb, at the present time—16½ years later (see Case 2 below). Seven of the 31 five-year cures of osteogenic sarcoma tabulated by Bartlett are my own cases. It is stated in error that all have had amputation. One, already referred to, recovered under toxins and irradiation, and the limb was saved.

Bartlett continues

"In reviewing the microscopic pathology one is struck by the preponderance of chondromatous tissue, and when one looks at each case as a whole he is further struck by the fact that none of the cured cases were truly typical of any of the known forms of osteogenic sarcoma. This group of thirty-one cures, therefore, probably does not indicate the real situation and for the present we must consider the clinically typical case of osteogenic sarcoma as incurable."

I do not believe that the presence of cartilage or chondromatous elements in the tumor indicates a low degree of malignancy. In the opinion of Geschickter "primary myxochondrosarcoma is extremely malignant" of 77 cases of this type there are only from 3 to 5 per cent five-year cures after amputation.

For some reason not known to me Bartlett chooses to regard these 31 five-year recoveries as not true osteogenic sarcomas but as 'atypical' cases. The question is what does he mean by a 'typical osteogenic sarcoma'? This I believe is a good example

of what takes place when the refinement of histologic classification is permitted to run wild and to create a much different impression from that which the facts warrant. In each of these 31 cases the diagnosis was confirmed by the Committee of the Bone Sarcoma Registry, all members of which are unusually well-versed in the diagnosis of bone tumors. If such a committee is unable to make a correct diagnosis of osteogenic sarcoma, then we might well regard the question as hopeless. Frankly speaking, I myself after a long clinical and histologic study of bone tumors, extending over a period of more than forty years, am unable to say exactly what is meant by a "typical osteogenic sarcoma." While some writers apparently regard a typical osteogenic sarcoma as one associated with a large amount of new bone formation radiating at right-angles to the shaft of the bone, Kolodny has shown that this group represents only about 18 per cent of all cases of osteogenic sarcoma. While there is often a marked variation in the degree of malignancy, our ability to diagnose these variations depends much more upon the clinical than upon the histologic evidence. According to Kolodny, the attempts of pathologists to form a prognosis on a tumor from its pathologic and morphologic features alone has nowhere failed more than in bone tumors. To make such a broad statement is Bartlett's that "we must consider the clinically typical case of osteogenic sarcoma as incurable," is not in my opinion in accord with the facts. It is certainly not supported by the end-results obtained at the Memorial Hospital, the Hospital for Ruptured and Crippled, Johns Hopkins Hospital, or the Bone Registry. Our own series contains no less than 24 cases of osteogenic sarcoma, as typical as one could hope to find the diagnosis in most cases having been confirmed by Twing and in many by the committee of the Bone Sarcoma Registry. All show definite clinical evidence of malignancy

nancy, and all were well from five to twenty-eight years after amputation. With results such as these, I cannot understand how Bartlett can make the following statement:

"We have learned to allow our patients who are suffering with malignant bone disease to die whole under the comforting and pain-relieving effects of x-ray and morphine, and we have learned to carefully preserve the limbs affected with non-malignant disease, thus saving their owners from a life of mutilation, deformity, and disability."

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The result obtained in this case illustrates the importance of continuing the treatment over a long period of time.

Case 3. *Osteogenic sarcoma (No. 100, Bone Registry) of the lower end of the femur treated with prolonged irradiation (radium)*



Fig 3 Osteogenic fibrosarcoma of humerus. It was impossible to make a diagnosis for nearly four years in spite of repeated biopsies and roentgenograms. Treated with prolonged irradiation, amputation, death from metastases a few months later.

and toxins, later, amputation followed by prolonged prophylactic toxin treatment. Patient was well for eleven years and then died of metastases—Mrs W P, aged 30 years, complained of a stiff knee and loss of weight over a period of one year, accompanied by gradual increase in the size of the joint. She had been advised by Dr George E Brewer and Dr George D Stewart, of New York, to have an immediate amputation, but this was not performed at the time. She entered Dr Howard Kelly's Hospital in Baltimore, where under the care of Dr C F Burnham, she received 125,761 mc-hrs of radium between Oct 23, 1916, and Jan 11, 1917. She then returned to Dr J M T Finney, who performed an exploratory operation and referred the patient to me for toxin treatment. A diagnosis of periosteal sarcoma had been made.

For five months she was treated with im-

jections of Coley's toxins supplemented by one application of the radium pack (7,200 mc-hrs). Little improvement was noticed, and I finally performed an amputation on July 6, 1917. Microscopic report by Dr Ewing: Periosteal osteogenic sarcoma of the sclerosing type.

Under prolonged prophylactic treatment with Coley's toxins the patient remained well for nine years. She then developed a hard nodule, the size of a small marble, in the labium major. Under novocaine I removed it and found it to be a bony tumor that, without decalcification, could not be cut. Sections showed unusual conditions interpreted in different ways by several pathologists. In the opinion of Dr Jeffries, pathologist of the Hospital for Ruptured and Crippled, the present condition had some connection with the original sarcoma of the femur. In the opinion of Dr Ewing and Dr Symmers, the sections showed no evidence of malignancy.

In July, 1928, the patient complained of pain in the mid-scapular region. Roentgen-ray examination in early August showed a degenerative process at the junction of the fourth rib and spine, apparently involving both, with some new bone formation as well, the condition being regarded as metastases from the original tumor. Examination at the time of the patient's admission to the hospital, two weeks later, showed a definitely palpable tumor of the scapular region apparently originating in the ribs. In spite of intensive radium and toxin treatment, the disease steadily progressed. At the end of two months a roentgenogram of the chest showed definite evidence of pulmonary metastasis. All treatment, other than symptomatic, was discontinued and the patient died shortly thereafter.

In this case I believe the long postponement of a recurrence of the disease was due to the inhibitory action of the toxins. The diagnosis of the Bone Sarcoma Registry was that of osteogenic sarcoma. By some error this case has been registered under the name of Pseudogood (No 100).

Case 4: Periosteal osteogenic sarcoma (Bone Sarcoma Registry No 1552) of the

upper end of the humerus treated by brief preliminary irradiation (x-rays for one week), amputation, and post-operative toxin treatment. Patient was well seven and one-half years later—K C, female, aged 34 years, was admitted to the Memorial Hospital on Aug 22, 1925, with a history of having noticed pain in both arms for a period of six months. The condition was regarded as rheumatic. Three weeks before admission, the right arm became swollen and increasingly painful. Physical examination revealed a hard, irregular, fixed, tender, bony tumor extending all about the shaft of the upper third of the right humerus and the head of the humerus. The x-ray report stated "A typical osteogenic sarcoma is seen involving the upper third of the right humerus. No evidence of metastasis in the films of the lungs." Treatment consisted of pre-operative roentgentherapy, one full erythema dose through each of two portals given from Aug 25 to 28, 1925. Shoulder-joint disarticulation performed on Sept 16, 1925. Colcy's toxins were begun immediately after the amputation and continued for four or five months at home by the patient's family physician.

Microscopic examination by Dr Ewing "Osteogenic sarcoma, very cellular, much new, rather typical bone formation." This diagnosis was confirmed by the Bone Sarcoma Registry Committee.

In view of the statement frequently made that there is no record of a metastasizing osteogenic sarcoma originating in an old osteitis fibrosa cystica, the following case is of interest (see Figs 5 and 6). It is the third of its kind that has been observed at the Memorial Hospital.

Case 5. *Osteitis fibrosa cystica treated by irradiation, amputation nine years later.* Microscopic diagnosis. Osteogenic sarcoma. Metastasis to lungs, death—M G, female, aged 13 years, was admitted to the Memorial Hospital on the service of Dr Quick on April 17, 1919. Six years previously the patient had suddenly felt pain in the upper part of the right tibia and a swelling had developed almost immediately thereafter. The pain sub-



Fig 4 Same case as shown in Figure 3, three years later

sided in a few days but the swelling remained. There was no further trouble until April, 1919, when the patient had a similar attack of sudden severe pain associated with swelling.

Physical examination on admission showed a swelling of the anterior and upper portion of the right tibia measuring  $9 \times 5$  inches. There was some tenderness on deep pressure. A clinical diagnosis of benign osteosarcoma was made. Roentgenological diagnosis was osteitis fibrosa cystica. A course of roentgen-ray treatment was given.

Follow-up notes stated as follows: Condition improved as shown by lessening of the size of the areas involved and increased amount of calcification" (March 18, 1920). "Very little change noted" (June 22, 1927). "Definite increase in the pathologic condition over the upper part of the tibia" (Aug 18, 1927). Radium pack treatment, 14,000 mc-hrs" (Aug 22, 1927). "Radium pack treatment, 12,000 mc-hrs" (November 1927).

The patient was shown at the Memorial



Fig 3 Osteogenic fibrosarcoma of humerus. It was impossible to make a diagnosis for nearly four years in spite of repeated biopsies and roentgenograms. Treated with prolonged irradiation; amputation; death from metastases a few months later.

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In this case I believe the long postponement of a recurrence of the disease was due to the inhibitory action of the toxins. The diagnosis of the Bone Sarcoma Registry was that of osteogenic sarcoma. By some error this case has been registered under the name of Blood-good (No. 100).

Case 4. Periosteal osteogenic sarcoma (Bone Sarcoma Registry No. 1352) of the

upper end of the humerus treated by brief preliminary irradiation (x-rays for one week), amputation, and post-operative toxin treatment. Patient was well seven and one-half years later.—K. C., female, aged 34 years, was admitted to the Memorial Hospital on Aug 22, 1925, with a history of having noticed pain in both arms for a period of six months. The condition was regarded as rheumatic. Three weeks before admission, the right arm became swollen and increasingly painful. Physical examination revealed a hard, irregular, fixed, tender, bony tumor extending all about the shaft of the upper third of the right humerus and the head of the humerus. The x-ray report stated "A typical osteogenic sarcoma is seen involving the upper third of the right humerus. No evidence of metastasis in the films of the lungs." Treatment consisted of pre-operative roentgentherapy, one full erythema dose through each of two portals given from Aug 25 to 28, 1925. Shoulder-joint disarticulation performed on Sept 16, 1925. Coley's toxins were begun immediately after the amputation and continued for four or five months at home by the patient's family physician.



Fig 4 Same case as shown in Figure 3, three years later

Microscopic examination by Dr. Ewing: "Osteogenic sarcoma, very cellular, much new, rather typical bone formation." This diagnosis was confirmed by the Bone Sarcoma Registry Committee.

In view of the statement frequently made that there is no record of a metastasizing osteogenic sarcoma originating in an old osteitis fibrosa cystica, the following case is of interest (see Figs 5 and 6). It is the third of its kind that has been observed at the Memorial Hospital.

*Case 5. Osteitis fibrosa cystica treated by irradiation, amputation nine years later. Microscopic diagnosis: Osteogenic sarcoma. Metastasis to lungs, death.*—M. G., female, aged 13 years, was admitted to the Memorial Hospital on the service of Dr. Quick on April 17, 1919. Six years previously the patient had suddenly felt pain in the upper part of the right tibia, and a swelling had developed almost immediately thereafter. The pain sub-

sided in a few days but the swelling remained. There was no further trouble until April, 1919, when the patient had a similar attack of sudden severe pain associated with swelling.

Physical examination on admission showed a swelling of the anterior and upper portion of the right tibia, measuring  $9 \times 5$  inches. There was some tenderness on deep pressure. A clinical diagnosis of benign osteosarcoma was made. Roentgenological diagnosis was osteitis fibrosa cystica. A course of roentgen-ray treatment was given.

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The patient was shown at the Memorial



Fig 5 (June 1919) Typical osteitis fibrosa cystica treated by irradiation. Amputation nine years later. Microscopic diagnosis: osteogenic sarcoma. Pulmonary metastases: death.

Hospital staff-conference in the latter part of January, 1928, and an amputation was advised. This was performed by Dr. Quick on Feb. 2, 1928. A specimen was examined microscopically by Dr. Ewing whose diagnosis was that of osteogenic sarcoma with large polyhedral cells. The patient developed pulmonary metastasis shortly thereafter and died.

*Periosteal Fibrosarcoma* — Inasmuch as the number of cases of osteogenic sarcoma that have shown marked and continued improvement from irradiation alone or from toxins and irradiation is very small, it might

be well to study these cases more carefully and try to find out if they have anything in common which might help us in deciding on the advisability of substituting conservative treatment for amputation in certain cases of osteogenic sarcoma.

At the Memorial Hospital we have had four cases which have not only shown marked improvement under toxins and irradiation, but in which the tumors have apparently disappeared and the patients have remained well from two to three years. A brief report of these cases may be of interest.

Case 6. Male, aged 47 years, was admitted to the Memorial Hospital on Aug. 6, 1930, for a tumor of the tibia. The microscopic report on the biopsy specimen was fibrosarcoma. There was a history of "rheumatic pain" in the right tibia for fifteen or twenty years. In the Summer of 1930 an exploratory operation was performed at the Sydenham Hospital, and a microscopic diagnosis of osteogenic sarcoma was made, later confirmed by Dr. Ewing. Roentgen-ray examination showed an area of bone destruction in the upper third of the tibia, breaking through the cortex but not infiltrating the soft parts. Erythema doses of radium in three fields were given. While at the Memorial Hospital the patient received 50,000 mc-hrs. of radium in the form of an element pack applied by Dr. J. J. Duffy between July 31, 1930, and Aug. 31, 1930. In September treatment with Coley's toxins was begun, 15 doses (3 a week) five being injected intramuscularly and the rest intravenously. The swelling, which was never very marked, slowly diminished in size until it had entirely disappeared. The patient is in good condition at the present time, two and one-half years later.

In this case the clinical, roentgenologic and pathologic evidence all showed that we were dealing with a slowly developing fibrosarcoma of moderate malignancy, a type that may well be treated conservatively, that is, by irradiation and Coley's toxins, instead of by immediate amputation. The same may



be said of the following case, also, in which the roentgenogram showed no evidence whatever of bone involvement. Evidently the tumor started either in the periosteum or the fascia, was attached to the periosteum, and never really invaded the cancellous portion of the bone. The pathologic report was of special value in helping to determine the type of treatment to be employed.

**Case 7** Female, aged 36 years, was admitted to the Memorial Hospital on May 23, 1930, with a history of having first noticed a firm mass in the upper and middle third of the right humerus on the anterior side 14 months previously. It was only moderately tender and not painful. In January, 1930, a biopsy was performed by Dr. Dickinson, of Christ Hospital, New Jersey, and the specimen, submitted to Dr. Ewing, was pronounced a fibrosarcoma. Physical examination on her admission to the Memorial Hospital showed a recent scar, 6 cm long, in the middle and upper third of the right arm. Beneath the scar, and extending several centimeters in either direction, was a firm, slightly movable swelling, the overlying skin was attached. On deep palpation, one gathered the impression of a band of firm fibrous tissue encircling the humerus which itself was not apparently enlarged.

**Treatment**—On May 19, 1930, four platinum needles containing 146 mc of radium were inserted in the tumor (total dose 1,314 mc-hrs), and again on May 30 (total dose 1,281 mc-hrs). Between May 10, 1930, and May 11, 1930 the radium element pack was applied posteriorly and anteriorly (total dose 10,000 mc-hrs). In addition on May 6 the patient received one 15-minute exposure of high voltage roentgen ray.

Examination on July 23, 1930 showed evidence of regression. By October, 1931, the local condition was nearly normal. By November, 1932 (two and one half years after admission), there was no evidence of the tumor remaining and there was excellent function of the arm in all directions. The pa-



Fig 6 Same case as shown in Figure 5 in January 1928 or nine years later just before amputation was performed.



Fig 5 (June 1919) Typical osteitis fibrosa cystica treated by irradiation. Amputation nine years later. Microscopical diagnosis: osteogenic sarcoma. Pulmonary metastases: death.

Hospital staff-conference in the latter part of January, 1928, and an amputation was advised. This was performed by Dr. Quick on Feb. 2, 1928. A specimen was examined microscopically by Dr. Ewing, whose diagnosis was that of osteogenic sarcoma with large polyhedral cells. The patient developed pulmonary metastasis shortly thereafter and died.

*Periosteal Fibrosarcoma* — Inasmuch as the number of cases of osteogenic sarcoma that have shown marked and continued improvement from irradiation alone or from toxins and irradiation is very small it might

be well to study these cases more carefully and try to find out if they have anything in common which might help us in deciding on the advisability of substituting conservative treatment for amputation in certain cases of osteogenic sarcoma.

At the Memorial Hospital we have had four cases which have not only shown marked improvement under toxins and irradiation, but in which the tumors have apparently disappeared and the patients have remained well from two to three years. A brief report of these cases may be of interest.

**Case 6** Male, aged 47 years, was admitted to the Memorial Hospital on Aug. 6, 1930, for a tumor of the tibia. The microscopic report on the biopsy specimen was fibrosarcoma. There was a history of "rheumatic pain" in the right tibia for fifteen or twenty years. In the Summer of 1930 an exploratory operation was performed at the Sydenham Hospital, and a microscopic diagnosis of osteogenic sarcoma was made, later confirmed by Dr. Ewing. Roentgen-ray examination showed an area of bone destruction in the upper third of the tibia, breaking through the cortex but not infiltrating the soft parts. Erythema doses of radium in three fields were given. While at the Memorial Hospital the patient received 50,000 mc-hrs. of radium in the form of an element pack applied by Dr. J. J. Duffy between July 31, 1930, and Aug. 31, 1930. In September treatment with Coley's toxins was begun, 15 doses (3 a week) five being injected intramuscularly and the rest intravenously. The swelling, which was never very marked, slowly diminished in size until it had entirely disappeared. The patient is in good condition at the present time, two and one-half years later.

In this case, the clinical roentgenologic, and pathologic evidence all showed that we were dealing with a slowly developing fibrosarcoma of moderate malignancy, a type that may well be treated conservatively, that is, by irradiation and Coley's toxins, instead of by immediate amputation. The same may

later showed a central osteolytic tumor of the tibia occupying two different areas several inches apart, so that the injury, apparently, had no causal relationship with the development of the tumor. A biopsy was performed by Dr T Wallace Davis at the Hospital for Ruptured and Crippled on August 5, 1931. The sections were examined microscopically by Dr Ewing, who reported "Low grade, slowly growing fibrosarcoma of medullary origin. Not very malignant or likely to produce metastases." Under roentgen therapy (four exposures, ten minutes each between September 2 and 11) the patient showed marked improvement and is still well at the present time, one and one-half years later.

The results obtained in the foregoing cases (Nos 6 to 10) justify, I believe, the employment of conservative treatment (irradiation and Coley's toxins) in this comparatively small group of so-called periosteal fibrosarcoma of the long bones. This type is characterized by little or no new bone formation, and with little involvement of the cancellous portion of bone. The roentgenogram furnishes the best guide to treatment in revealing the absence of new bone and the slight invasion of the cortex. Even in endothelial myeloma, a type of bone sarcoma that is known to be radiosensitive, we have found that in those rare cases in which considerable new bone is present, the disease is highly resistant to both irradiation and Coley's toxins.

*Results Obtained in Memorial Hospital Series*<sup>a</sup>—A brief analysis of 168 cases of primary operable osteogenic sarcoma of the long bones treated by irradiation, with or without surgery, and including 39 cases in which Coley's toxins were used, shows the following:

Method Employed	Cases
Roentgen ray	84
Roentgen ray and radium	10
Radium (element pack in 30 cases)	35
Irradiation and Coley's toxins	39
	<hr/> 168

<sup>a</sup>In 10 cases the x-ray treatment had been carried out at other hospitals before the patient came under my observation.

Of the 84 cases treated by the roentgen ray, the only five-year cures occurred in two cases in which amputation was performed after irradiation, and in one case treated by resection following by irradiation.

Of the 10 cases treated by roentgen ray and radium, five-year cures occurred in two cases in which amputation was performed after irradiation.

Of the 35 cases treated by radium alone, the only five-year cure occurred in a case in which amputation was performed after irradiation, and in one case treated by resection and irradiation.

In other words, of 129 cases of osteogenic sarcoma treated by irradiation, there were no five-year cures obtained without amputation or resection, there were 7 five-year cures (or 5.42 per cent) with amputation or resection.

The tumors were situated as follows:

	Cases	Five-year Recoveries
Femur	53	3
Humerus	35	4
Tibia	24	0
Fibula	7	0
Radius and ulna	5	0
Metatarsal	1	0
Metacarpal	1	0
Tarsus (not long bone)	3	0
	<hr/> 129	<hr/> 7

Of the 39 cases treated by irradiation and Coley's toxins, there were four five-year cures obtained without amputation, and two with amputation. Three other cases in which the limb was saved have remained well from two to four and one-half years. One of the five-year cures without amputation was an extensive tumor of the humerus treated with irradiation and toxins over a period of one year. While the Bone Sarcoma Registry Committee at first classified it as an osteogenic sarcoma five years later they revised their diagnosis to that of giant-cell tumor. Excluding this case, we have five five-year cures in a group of 39 cases (13.05 per cent).

tient still remains well at the present time, nearly three years after admission.<sup>4</sup>

Case 8 A F, female, aged 40 years, noticed pain and swelling following a fall in April 1929, when she fractured her right humerus and scapula. Five months later an operation was performed at the Troy Hospital and the patient was then referred to me. Examination on her admission to the Hospital for Ruptured and Crippled showed considerable atrophy and weakness of the right arm below the elbow, swelling at the middle third, and contracture of the fourth and fifth fingers of the right hand. A provisional diagnosis of osteogenic sarcoma was made.

Treatment was with Coley's toxins and irradiation. From October 12 to October 24 she received 16,000 mc-hrs of radium in the form of a pack, on November 20, 7,000 mc-hrs, and on December 20, another 7,000 mc-hours. Coley's toxins were given in increasing doses over a period of six months.

Microscopic report by Dr Ewing was osteogenic fibrosarcoma, a diagnosis in which the Bone Sarcoma Registry committee concurred but which the latter, about a year later, revised to ossifying hematoma. The patient remains in excellent condition at the present time, four years later.

In this case the roentgenographic report, made by Dr R Lewis, of the Hospital for Ruptured and Crippled, on December 21, 1929, is of interest. "The x-rays of the right arm suggest that there is a tumor of the soft tissues which has formed a ring of calcium on its surface and which has caused a loss of bone substance from the shaft of the humerus due to pressure upon the bone and not due to invasion."

Case 9 T LeP, female, aged 19 years, was admitted to the Memorial Hospital in December, 1929, with a history of persistent but not severe pain in the right knee for two months, and swelling at the same site for one month.

*X-ray Report (December 14, 1929)*—Films of the right tibia faintly revealed slight

changes in the external tuberosity, head of tibia. Diagnosis osteogenic sarcoma. A short course of irradiation (roentgen ray) was given, and on March 25, 1930, a biopsy was performed by Dr Bradley L Coley.

*Microscopic Report*—Osteogenic sarcoma. Small foci of cellular tumor, rather radiosensitive. Considerable osteoid stroma, with calcific deposit (not bone). Radiation thrombosis of vessels.

Further irradiation in the form of the radium pack (32,000 mc-hrs) was applied in early April, in addition, Coley's toxins were given intravenously in gradually increasing doses. The patient was discharged on May 1, 1930, with the following note: "Case reviewed with Dr Ewing, who believes it safe to await developments rather than proceed with amputation. Patient in good general condition, has fine flexion of knee and almost complete extension, no pain, practically no swelling." Examination by Dr Bradley L Coley on May 28, 1930, showed there was no increase in the size of the knee at the level of the tumor. Palpation revealed no apparent growth. The patient was able to flex and extend her knee within normal limits. She had no pain and had gained ten pounds in weight in the previous three weeks.

*X-ray Report (May 3, 1931)*—The process in the upper end of the tibia showed evidence of definite improvement and bone regeneration when compared with previous films. There was no evidence of pulmonary metastasis.

In February, 1933 (or three years later), the patient was shown at the weekly conference of the Memorial Hospital staff, at which time she was in excellent physical condition.

*Medullary Central Fibrosarcoma of the Tibia*—Case 10 H F, male, aged 21 years, was admitted to the Memorial Hospital on September 2, 1931, with a negative family history. He stated that on June 18, 1931 less than three months prior to his admission he had struck his right shin against a barrel. However, a roentgenogram taken a few days

<sup>4</sup>The total depth tissue dosage for the element pack roentgen ray and platinum needles was 540 per cent surface erythema dose.

<sup>5</sup>The patient remained well until Aug 1, 1933, nearly four years when she received a blow over the exact site of the old sarcoma. Within a week signs of activity developed and by Aug 24 there was a well marked recurrence. Amputation was advised.

3 Osteogenic sarcoma of upper end of humerus, amputation followed by prolonged treatment with Coley's toxins. Patient well eight years later.

4 Osteogenic sarcoma of upper end of humerus. Patient seen in consultation with Dr J. Baptist Blake in 1898, and treated under my direction, exploratory operation, condition believed to be beyond amputation. Diagnosis of osteosarcoma confirmed by Dr Mallory, Professor of Pathology, Harvard Medical School. Recovered under Coley's toxins alone. Remained well for 24 years and then died of spinal metastasis.

5 Periosteal osteogenic spindle-cell sarcoma of humerus. Patient of Dr John H. Gibbon. Treated under my direction with toxins and x-rays. In excellent condition when last traced 17 years later.

6 Periosteal osteogenic sarcoma of humerus, upper end, resection by Dr J. M. Hitzrot. Patient referred to Memorial Hospital for after-treatment, radium pack applied by Dr Janeway and myself. Patient well 12 years later.

7 Periosteal spindle-cell osteogenic sarcoma of upper end of humerus, with very little involvement of the cancellous bone. Roentgen-ray treatment followed by resection. Patient well 10 years later.

Cases 8 and 9 both endothelial myelomas both well 10 years later.

At the present time we have 56 five-year recoveries of sarcoma of the long bones, 33 of the osteogenic and 23 of the endothelial myeloma type.

#### SUMMARY

In the 33 cases of osteogenic sarcoma of the long bones well five years the toxins were used in all but eight cases the treatment is summarized as follows:

Amputation alone one case

Amputation followed by Coley's toxins 18 cases

Toxins alone 2 cases

Toxins and radiation 4 cases. The limb was saved in these six toxin cases.

One other case, periosteal sarcoma of finger, diagnosis confirmed by Welch and Ewing, excision of tumor only, with prolonged toxins. Patient was well for 20 years.

Irradiation alone no cases

Prolonged irradiation, followed by amputation 5 cases

Irradiation (x-ray), followed by resection of upper end of humerus one case, well for 10 years

Resection of upper end of humerus, followed by radium treatment one case, well for 10 years

In addition to the 33 five-year cures of osteogenic sarcoma of the long bones, I have had 11 cases of five-year cures of flat bones (well for from 8 to 32 years).

Toxins alone 5 cases

Toxins and irradiation 5 cases

One periosteal sarcoma of the mastoid toxins and three x-ray treatments, after four operations failed to control disease well 10 years.

All of these cases were quite operable at the time they came under my care.

#### CONCLUSIONS

Shall we conclude that irradiation has no place in the treatment of sarcoma of the long bones? By no means. This study of end-results, however, in my opinion, forces us to the following conclusions:

1 The routine treatment of early operable cases of osteogenic sarcoma by irradiation, which has become more and more general in recent years, should be abandoned.

2 Preliminary or pre-operative irradiation, *i. g.*, for a few weeks or a month, while waiting for a number of radiologists to pass on the roentgenograms, is without justification and is associated with grave risks.

3 While our present data are insufficient to permit a positive opinion as to the value of post-operative irradiation after amputa-

Of the total number of 168 cases treated by irradiation, 102 went on to amputation

	Cases
Femur	45
Humerus	19
Tibia	27
Fibula	8
Radius	1
Metatarsal	1
Metacarpal	1
	<hr/> 102

In nearly every case irradiation was given over a long period of time, that is, at least several months, or until it became evident that the disease could not be controlled or until metastases developed.

We have another group of 46 cases of operable osteogenic sarcoma of the long bones treated by amputation followed by post-operative toxin treatment *without* prolonged pre-operative irradiation. In this group, 14 (30.43 per cent) have remained well for five years or more.

A study of these statistics shows that while the results obtained by prolonged irradiation and Coley's toxins are a little better than those obtained by irradiation without toxins, they are decidedly inferior to the results obtained by early amputation without preliminary irradiation, followed by prophylactic toxin treatment.

*Five-year Recoveries*—Inasmuch as the number of cases of periosteal sarcoma of the femur well five years after disarticulation or high amputation has proved exceedingly small, and the number of five-year recoveries of sarcoma of the humerus almost nil, the results noted in our series should be of interest. (For more details see *Annals of Surgery*, March 1933.) We have 24 cases of sarcoma of the femur that have remained well for five years, 13 were of the osteogenic and 11 of the endothelial myeloma type. All of the 13 osteogenic sarcomas were of the periosteal or subperiosteal (older classification) type, a type in which Butlin found only one three-year recovery in 68 cases treated by disarticulation or high amputation. In every one of these

13 cases the diagnosis was confirmed by microscopic examination by leading pathologists. The method of treatment employed was amputation plus Coley's toxins in 10 cases (well from 8 to 27 years), and amputation after prolonged irradiation in three cases (well from 5 to 12 years).

Of the 11 endothelial myelomas of the femur well over five years, two were treated by amputation plus Coley's toxins, six by Coley's toxins alone, and three by toxins and irradiation. In six cases the limb was saved by toxins and irradiation in two, and by toxins alone in four cases. Six were inoperable and two had extensive metastases at the time treatment was begun.

A study of our humerus cases proves even more interesting, especially in view of Bloodgood's statement that he knew of no case of sarcoma of the humerus above the middle third cured by amputation, and in view of the total absence of cures in the records of the English clinics. Of nine five-year recoveries of sarcoma of the humerus, seven were of the osteogenic and two of the endothelial myeloma type. A microscopic examination confirmed the diagnosis in the seven cases of osteogenic sarcoma.

#### BRIEF SYNOPSIS OF FIVE-YEAR RECOVERIES OF SARCOMA OF HUMERUS

1 Rapidly growing osteogenic sarcoma starting a little above the middle of the humerus following a recent fracture, practically disappeared under Coley's toxins alone, pathologic fracture united, recurrence near upper portion, amputation at shoulder joint, metastasis in pectoral region, incomplete operation followed by Coley's toxins. Patient well eight years and then died of pulmonary metastasis.

2 Telangiectatic sarcoma of middle and upper thirds of humerus treated for four months with the roentgen ray then amputation. Patient well nine years later.<sup>7</sup>

<sup>7</sup>In 1922 Dr. Ewing stated that there was no record of a cure of telangiectatic sarcoma by any method of treatment.

3 Osteogenic sarcoma of upper end of humerus, amputation followed by prolonged treatment with Coley's toxins. Patient well eight years later

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3 While our present data are insufficient to permit a positive opinion as to the value of post-operative irradiation after amputa-

tion, my own feeling, supported by that of Forssell and others, is that osteogenic sarcoma is so radioresistant that it is doubtful if irradiation would control pulmonary metastasis that might have been present but undetected at the time of the amputation.

4 There is a type of osteogenic sarcoma known as "periosteal fibrosarcoma," characterized by little involvement of the bone itself, and of a much lower degree of malignancy than is the ordinary osteogenic sarcoma, that we have found most responsive to treatment. Three patients with this type have remained well for three years and one for nearly two years, one was treated by irradiation alone, and three by irradiation combined with Coley's toxins. While the period of time is too short to allow us to regard these cases as cures, I believe we are justified in using conservative treatment in this type of bone sarcoma, notwithstanding statements that no case has been found permanently cured with anything short of amputation.

5 For all other types of operable osteogenic sarcoma of the long bones, I believe that an amputation as soon as the diagnosis has been made, followed by prolonged treatment with Coley's toxins, is the method of choice. This method has given a much higher percentage of five-year cures than has amputation alone or amputation following prolonged irradiation.

6 The endothelial myeloma type of bone sarcoma is highly sensitive to both irradiation and Coley's toxins. While this type has often shown immediate and rapid improvement under irradiation alone—in some instances amounting to complete disappearance of the tumor in a few months—for some unknown reason this result has seldom proven to be lasting, recurrence or metastasis has developed within six months to a year, with a fatal ending in nearly every case. In cases of operable endothelial mye-

loma of the long bones we believe conservative treatment—local irradiation and Coley's toxins, should be tried for from four to six weeks before advising amputation.

7 Irradiation is of considerable value in many cases of inoperable osteogenic sarcoma because of the retarding effect upon the growth of the tumor and the relief of pain. On the other hand, the pain is not always relieved by irradiation, and the retarding effect may be of short duration.

8 It is well to recognize that there are certain cases of far-advanced inoperable osteogenic sarcoma which had best be treated without irradiation or toxins. Small doses will be of little avail, and irradiation pushed to its limits has not infrequently caused severe burns that heal but slowly or never heal, thus greatly aggravating the sufferings of the patient. Morphine is the method of choice for such cases.

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# THE PHYSIOLOGIC INTERPRETATION OF DUODENAL MOTILITY<sup>1</sup>

By N S ZEITLIN, M D, Edgewater Hospital, CHICAGO

THIS subject is far from settled and unanimity of opinion is still being sought in the interpretation of duodenal motility. Various clinicians are attributing symptom-complexes to supposedly pathologic contractions of the duodenum (19), and are suggesting operative procedures as a cure. Certainly a disturbance demanding such radical treatment cannot be studied too carefully or too frequently. The following impressions are the result of five years of observation.

At first, all gastric cases were observed and studied and notes were made on the motility, form, and size of the duodenal curve. This group comprises well over two thousand cases studied at the Cook County Hospital. Later, as comparative studies became necessary, five other groups were added. These were as follows:

- 1 Visceroptosis with no abdominal complaints, 50 cases
- 2 Hypertonicity with no abdominal complaints, 50 cases
- 3 Proven gall-bladder pathology 50 cases
- 4 Gastric ulcer, 25 cases
- 5 Active duodenal ulcer, 100 cases

Before one can appreciate the possible disturbances in motility in the duodenum a short review of the anatomic relations is necessary (8). The first portion or duodenal cap usually leads upward and obliquely backward into the descending portion. The second portion comes in relation with the gall bladder so that infections in this organ have been frequently blamed for stasis and surging in the duodenal curve. The third or horizontal portion crosses the

spine and the aorta, and lies underneath the mesentery and superior mesenteric artery. Various authors have attributed apparent obstructive signs to a narrowing of the opening at the duodenojejunal flexure, at which the ligament of Treitz is found. Many peritoneal folds have been described, but they are rather rare and of little importance. Plain muscular fibers have been delineated in the ligament of Treitz. The possibility of sphincteric action at this point will be considered later. The nerve supply of the duodenum arises in the solar plexus, but there is also an intrinsic nerve supply from the Meissner plexus. This double nerve control may account for some of the variations seen in normal cases.

In the study of our cases, careful notes were taken of the 'size of the duodenal cap,<sup>2</sup> the angle formed by the cap and the descending portion, which we have called the cap angle,<sup>3</sup> the size of the descending portion,<sup>4</sup> the course over the spine, the length and steepness of the ascending portion, which we have called the duodenal climb, and the angle at the duodenojejunal junction,<sup>5</sup> which we have called the Treitz angle. Observers at different times have pointed to all of these anatomic divisions as the locations of frequent obstructions. Keeping this in mind, we studied the flow of the barium through these areas with and without manual aid and in the upright horizontal and reversed Fowler positions.

## VISCEROPTOSIS WITH NO ABDOMINAL COMPLAINTS

In the normal hypotonic individual the duodenal curve is usually "V"-shaped. The cap angle between the first and second portions is frequently sharp but in none of our

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30, 1924.



Fig 1 Arrows point to an apparent obstruction in the horizontal portion, which is, however, only physiologic delay. Dilatation of the duodenal curve is due to rapid emptying of the stomach in carcinoma of the antrum.



Fig 2 Apparent obstruction of the second portion which disappears after several minutes.

50 cases of visceroptosis was there any delay or obstruction at this point. In over 90 per cent of these cases, the second portion of the curve ended in a puddle which was moderately dilated. In 80 per cent slight but easily demonstrable delay was noted in the region of the superior mesenteric artery. Over 90 per cent showed an almost perpendicular duodenal climb to the Treitz ligament. About the same percentage of cases showed an apparent delay at the ligament of Treitz. Physiologic stasis was noted in every case. Stasis is difficult to evaluate, observers seem to disagree as to what stasis actually constitutes. Wheelon (2) considered stasis present when the barium had not moved on after the second gastric peristalsis. We believe that this definition presumes a dependence of duodenal motility on gastric peristalsis, is a step in the right direction. It is our opinion, however, that the motility of the duodenal curve depends not only on the stomach, but also on the stimulation of

the duodenal mucosa by the barium. The understanding of this double origin for peristalsis is essential to the correct interpretation of the motility of the duodenal curve.

When the hypotonic stomach first receives barium, it is most frequently quiescent. In the upright position, if peristalsis is present at all, it is feeble. Now if barium is forced by hand through the pylorus into the duodenal curve one of two things results: either the barium lies quietly in the curve (normal stasis), or else surging movements are present. In either type there is little or no forward movement of the barium. Stasis will be present as long as peristalsis in the stomach is absent or inefficient. It seems that the nervous stimulus associated with gastric peristalsis is carried over into the duodenum. We have seen stasis persist for over five minutes at a time in the duodenum with only an occasional writhing movement. The barium is seen incompletely outlining the second portion, but most of

it remains in a puddle at the lowest portion of the curve. We have called this physiologic stasis, as differentiated from pathologic forms, to be described later. The puddle is usually moderately dilated, but it is considered normal and not due to obstruction.

Surging movements in the duodenum were seen in practically every one of the normal hypotonic stomachs examined. Surging is evidenced first in the puddle by mild writhing movements. When more barium is forced by manipulation into the curve, the writhing increases until it reaches a state of surging. Now one can see a marked contraction ring start in the center of the puddle of barium, and travel both toward the bulb and the duodenojejunal flexure. This two-way action is characteristic. It may force the barium into the bulb or the stomach, and into the jejunum. We are impressed with the idea that this surging is an intrinsic effort on the part of the duodenal curve to pass the barium along without the aid of the stimulation from the progressive gastric peristalsis. If the curve is compressed by the finger just proximal to the two-way peristaltic movement, the peristalsis then becomes more effective and barium is shot through the duodenojejunal flexure. The finger supplies here what the ordinary *vis a tergo*, which plays an important part in duodenal motility, from the progressive gastric peristalsis normally supplies. These localized, non-progressive peristaltic movements in the duodenum have their counterparts in the stomach, when barium is first ingested by the patient in the upright position. At first the peristalsis is slight, occurs on one or the other curvature, is irregular in appearance, is very shallow, and does not reach the pylorus. As the stomach passes this irritable phase, the more normal progressive and complete peristalsis takes place. And so it is with the duodenal curve. Even when the progressive gastric peristalsis sets in quickly the duodenal curve may still



Fig 3 Marked organic constriction of the duodenal curve, due to carcinoma of the pancreas. Note the absence of dilatation of the cap. There was no surging during fluoroscopy. Even a very small lumen is sufficient to carry on the work of the duodenal curve.

show surging in the intervals between the gastric peristalsis. But in the light of the two origins of the nerve stimuli for duodenal motility, this can be readily understood. The surging here is due to the stimulation of the mucosa of the curve by the barium. After the gastric peristalsis has been well regulated for some time, the surging in the duodenum is considerably decreased. Very frequently we have waited for an interval of 30 minutes and then studied the duodenum again without giving more barium. It is surprising how little surging one will then see even with the patient in the upright position. The time element is important in judging the motility of the stomach and duodenum. If one will allow the patient to rest and then re-examine the stomach, the diagnosis of duodenal ob-



Fig 4 Apparent obstruction of the duodenal curve which disappears after several minutes. This is probably due to the root of the mesentery or to sphincteric action

struction and pathologic surging will be infrequent

A rather striking example of the necessity of gastric peristalsis, before normal motility arises in the duodenum, is seen in cases of hypotonia. As stated before, at the outset of the examination, one will see most frequently the physiologic stasis and surging associated with the atonic stomach. Now if the patient is placed in the right oblique horizontal position, the progressive movement of the barium is considerably improved. Because of this, many authors have concluded that this position overcomes the obstruction caused by the spine, mesentery, artery, etc. We cannot confirm their conclusion without many reservations. In practically all of such cases we have noted improvement in the duodenal motility, but always it followed the appearance of vigorous gastric peristalsis. It is apparent that the right oblique horizontal position is best for the onset of gastric peristalsis, and we consider this responsible for the improvement in duodenal motility. Now if the patient is placed in the supine position and barium is forced into the duodenal curve by

hand, stasis again sets in, simply because, in the supine position, the progressive peristalsis of the stomach is diminished.

This interrelation between gastric and duodenal peristalsis is also seen in those few cases in which active peristalsis is noted in the stomach at the beginning of the examination. In such cases, frequently the first portion of the barium swallowed shoots right through the duodenal curve and out past the ligament of Treitz. Later, as the stomach fills and becomes atonic, in the asthenic types, stasis and surging set in. This unusually rapid propulsion of the first bolus speaks against the theory of Carlson (18), who states that surging and stasis are physiologic for the purpose of mixing the duodenal contents with overflow gastric juices.

Several other observers, in attempting to explain surging pathologically, have reported a very close association between surging and belching. One author, Wheelon (2), believes this relation so close that, in his examinations, he was able to foretell accurately just when the patient would desire to belch. For this reason, many of the symptoms of dyspepsia have been attributed to duodenal surging. Our own observations have been entirely different. Repeatedly we tried to elicit complaints from patients during the period of surging, but we could never persuade ourselves that there was any interrelation between the findings. In this connection, it is interesting to note the effects of mild, shallow, reversed peristalsis in the stomach. We have observed many such stomachs and here, again, we have not been able to show any constant relation between reversed peristalsis in the stomach and belching. We are convinced that the cause of this symptom does not lie in what we are calling physiologic surging.

Still another method for studying the relation between stomach and duodenal motility is the artificial inducement of gastric

peristalsis in the upright position. By vigorously massaging the abdomen, peristalsis will ultimately set in and a distinct improvement will be seen in the duodenal motility.

#### THE HYPERTONIC STOMACH

The hypertonic stomach was studied in a group of 50 selected cases. In these, the duodenal curve is usually shorter, rounder, and does not rise as high as in the hypotonic type. The cases were studied along the same lines used in the hypotonic cases. The angles were carefully examined for obstruction, and the height of the duodenal climb measured.

That physiologic stasis was not as frequently seen as in the hypotonic cases is explained by the fact that, in the hypertonic types, active peristalsis in the stomach comes on immediately, stimulating progressive peristalsis in the duodenal curve. This is found to be true except in those cases in which pylorospasm is present. Here the duodenum shows only writhing. Occasionally the stomach is seen in a tonic contraction, showing deep, non-progressing, peristaltic waves. During this stage, stasis in the duodenal curve is noted, again indicating the close relation between progressive gastric peristalsis and duodenal motility.

Physiologic surging was frequently seen, but for short periods only. Occasionally the surging was marked and barium was swept back in the bulb, which can be explained by physiology. In hypertonic types the intrinsic peristaltic mechanism is naturally more irritable. In these cases when barium is forced into the duodenum by hand there is an immediate attempt to move it along the canal. Frequently it is forced in an opposite direction. The relation between symptoms of dyspepsia and surging was again studied in this series and the same results obtained. No definite association was found to be present. There were other small differences between the hypertonic and



Fig 5 Normal stomach. Note the large cap and small duodenal curve. Normal variations.

hypotonic stomachs, for example, the puddle formation was very rarely seen. The curve itself was rounder. Angulations were very rare. The duodenojejunal flexure was almost never in question. In short, the hypertonic type of duodenal curve rarely caused any difficulty in differentiating between the normal and the pathologic.

#### SUPERIOR MESENTERIC ARTERY

Numerous observers (7) have reported cases of obstruction with symptoms due to compression of the third portion of the duodenal curve by the superior mesenteric artery, the root of the mesentery, or the ligament of Treitz (16). They have gone so far as to devise operations in which the duodenal contents are shunted into the jejunum so that the question has a serious aspect. In the several thousand cases we examined we were not able to convince ourselves of a single definite case of pathologic obstruction at the root of the mesentery, or the mesenteric artery. And in spite of

many observations by surgeons during operations, we have never been able to demonstrate a pathologic kinking at the ligament of Treitz in an adult. Such discrepancies in observations are striking, and it may just be that here, again, it is a question of definition. What shall constitute a state of obstruction? We do not believe that narrowing to the touch of the finger at operation is sufficient. We have already shown that stasis and surging are dependent upon the type of stimulation of the duodenum, and not upon the presence of obstruction. What then shall we mean by obstruction?

In our work, we laid down the following prerequisites before making a diagnosis of pathologic obstruction:

1 *Strong, but Ineffective Peristalsis*—The peristalsis must be vigorous beyond the normal. In this connection, significant observations can be made on the stomach which is laboring against a pyloric obstruction. One will note here vigorous hyperperistalsis, which is not able to force the barium through into the duodenal bulb. As the wave approaches the pylorus, the barium slips back into the pars media, through the center of the lumen of the stomach. This two-way flow of the barium is readily seen in cases of pylorospasm. Yet why do we not see reverse peristalsis in the stomach? The obstruction must be high-grade, indeed, before the reverse peristalsis is seen; even then peristalsis is only slight. Can we compare reverse peristalsis with the vigorous to-and-fro movement of the duodenal curve? We believe that the etiology is not the same. The reverse peristalsis of obstruction is slight, shallow, and never as active as that seen in the surging of the duodenal curve.

2 *Dilatation*—Wherever obstruction occurs in the course of a hollow viscus, dilatation is always seen proximal to the obstruction. Dilatation in every case is in direct proportion to the severity and duration of the obstruction. We could certainly expect considerable dilatation of the du-

odenal curve in an adult who has long had supposed obstruction. Yet, in all of these cases of surging, never once could we definitely determine more than a very slight dilatation of an obstructive nature. In cases of puddle formation, there is mild dilatation, but this is only a question of gravity, and the dilatation never goes beyond the borders of the puddle. It seems to us that, in any case of duodenal curve dilatation due to obstruction, the cap should also be dilated. This we have hardly ever seen without finding other congenital anomalies.

3 *Thickening of the wall of the viscus* is practically always seen if obstruction is present. This is important. If a surgeon reports narrowing of the duodenojejunal flexure, he must show that the duodenal curve is thickened, otherwise he cannot presume that the narrowing is the cause of symptoms.

The diagnosis of obstruction, however, is not without some foundation in many cases. While we do not consider them true pathologic obstructions, we have seen many cases presenting what we consider physiologic delay, at the superior mesenteric artery and the Treitz ligament. It is seen in about 70 per cent of all hypotonic cases. Barium fills the descending and transverse portions up to the region of the spine, then it is sharply cut off from the rest of the empty curve. This is seen best in the upright position. When the peristaltic wave becomes progressive in type the barium flickers through the physiologic compression. At the most there is only a slight clumping of the barium proximal to the artery when the duodenum is at rest. When peristalsis sets in the compression is easily overcome, even with the patient in the upright position. We have carefully examined our asthenic patients in all postures and we feel that this physiologic compression is only slight and that there is only a slight decrease of this compression in the horizontal position. The improvement of peristalsis in the duodenum in the hori-

zontal position is due to the onset of active gastric peristalsis, as has been shown previously. Writhing frequently appears to stop at the crossing of the artery, but this is only apparent. Because there is no barium in the distal half of the duodenum, writhing cannot be seen.

The same observations were made in the study of the delay noted at the duodeno-jejunal junction. Weak, ineffective waves frequently were unable to force the barium up the climb and through the junction, when the patient was in the upright position. Yet there was no dilatation proximally, there was no retention, and vigorous peristalsis found no difficulty in overcoming the angle. Occasionally the ascending portion of the duodenum was so steep and long that gravity alone kept the barium from spilling over into the jejunum. In such cases only vigorous peristalsis was effective. With weak peristalsis the barium fell back into the puddle. It is in the case with the long steep climb that improvement is noted in the prone position for then the action of gravity is removed and barium passes more readily into the jejunum.

In the hypertonic cases rarely was excessive pressure by the mesenteric artery seen. In addition there was seldom a long ascending portion of the curve so that progressive movement of the barium was more commonly noted.

We have now studied the motility of the duodenal curve in known normal asthenic and sthenic cases. We have seen that in certain types there is a certain amount of physiologic stasis and surging. Using this normal degree as a base line we recognize an abnormal increase of this phenomenon and it is so this finding significant for any particular symptom complex. For our study 100 cases presenting active duodenal ulcers were chosen. After calculating the results we were unable to find any increase over the normal in stasis and surging.

A series of 25 cases of gastric ulcer was similarly examined and here, also, no appreciable change in the duodenal motility was noted. Of course if pylorospasm existed, there was an increase in stasis, but this merely showed the importance of the *cis a tergo* principle in the duodenal motility and the necessity for a sufficient amount of barium before progressive peristalsis would occur.

To complete the study of the upper right quadrant, a carefully selected group of 50 cases of gall-bladder pathology was chosen. Here again the same results were found. There was no appreciable increase in stasis and surging. We realize that this is in direct contradiction to the work reported by Friedman, Strauss, and Arens (21) and it is not easy to account for such marked difference of opinion. We started this study with the conviction that increased surging would be found in ulcer and gall-bladder pathology, but we were forced to change our opinions. Some of the differences in reports may be attributed to the time of observation of the duodenum. We frequently found surging at first, and, later, more progressive peristalsis, when the stomach became more active. Again surging was often seen in the upright and not in the horizontal position. Results calculated on first observations might, therefore, be untrustworthy. We do not offer this as a criticism of the authors mentioned, but merely point out the necessity for prolonged observations in carrying out a study of these cases.

Theoretically several interesting deductions can be made. Those who point to surging as an indication of duodenitis due to gall-bladder or ulcer pathology do not take into consideration the action of the gastrointestinal musculature in known cases of inflammation. For example let us take a case of tuberculosis of the cecum. No one has described surging in such a case. On the contrary the increased irritability of the cecum keeps it practically free from barium



Fig 6 Normal physiologic delay at the right border of the spine. Active peristalsis has no difficulty in overcoming this apparent obstruction.

Inflammatory conditions of the intestines are usually associated with diarrhea. It is Nature's way of removing the foreign irritation. Why should inflammation in the duodenum behave differently from inflammation in any other hollow viscus? If there really were a duodenitis involving the descending portion, the last finding we would expect would be stasis and surging. In fact, the evidence appears to indicate that duodenitis is a rare occurrence and that when it is present it is of little importance in the x-ray examination.

Again, theoretically, we cannot confirm the diagnosis of intermittent duodenal obstruction (16). Those who report such cases claim that the obstruction is caused, during certain postures, by the superior mesenteric artery (13) or a narrow Treitz ligament (14). This explanation does not run parallel with the clinical findings in our cases. Very frequently the symptoms of dyspepsia will disappear for weeks at a time. Certainly, the anatomy of the duodenal curve did not change during our weeks of study. To afford some proof of this opinion we selected 15 cases of visceroptosis presenting symptoms of dyspepsia. We examined them during their periods of com-

plaint, noting the stasis and surging, and re-examined them during their periods of well-being. The stasis and surging were again noted, and to the same degree. In the face of these findings, we were forced to conclude that the duodenal curve motility was not the cause of the dyspepsia. To speculate, it is more likely that the anatomy remains constant and has nothing to do with the symptoms. Again, many of these cases complain of the same symptoms on an empty stomach and on a full stomach. If duodenal obstruction were really the cause of the complaint, the patient should be symptom-free on an empty stomach.

We have had 10 cases of large diverticula of the second portion of the duodenum. Stasis existed in these for at least 24 hours. Certainly one might expect symptoms, if stasis in the duodenum causes symptoms, yet in each case other definite pathology such as gall-bladder disease and ulcers, was found to account for the complaints of the patient.

Perhaps the most frequent cause given for supposed duodenal obstructions is compression by the mesenteric artery. This would seem to be supported by the post-mortem experiments carried out by McWhorter (7), who, when the mesentery was pulled downward, was able to demonstrate definite compression of the duodenum by the artery. It is significant that he was unable to cause similar compression by dragging on the ligament of Treitz. Our own clinical and fluoroscopic observations agree somewhat, but our interpretations are different. It is true that careful fluoroscopy will show a delay in the duodenal curve in the region of the spine in the upright position, but the degree of delay does not seem to vary with the drag on the mesentery. A patient with a very low hanging stomach does not seem to present more stasis and surging than one with moderate ptosis. Again, in the reverse Fowler position when the mesenteric drag is removed, stasis and surging do not disappear entirely. In any



event there is no associated dilatation of the proximal portion of the curve, and, as soon as vigorous gastric peristalsis sets in, the duodenal loop begins to empty nicely.

Acute angulation at the Treitz angle has also been mentioned as a cause of obstruction in asthenic types (25). It is true that, in the upright position, barium will be seen, particularly in asthenic cases with a steep duodenal climb, forcing its way up to the angle and then dropping back to the puddle. And yet, even in these cases, one frequently sees the barium leave the puddle and shoot right through the Treitz angle, which apparently is not narrowed. One can only conclude that there is no real obstruction to the right kind of progressive vigorous peristalsis. And yet a steep duodenal climb does cause delay in the upright position, for, in the horizontal, the tendency to fall back into the puddle is definitely decreased. We do not contend that there is no apparent evidence of obstruction, but we do say that it is only physiologic and frequently dependent upon the position of the patient.

One case in particular comes to our minds. The patient was a young laboratory technician who had irregular attacks of abdominal distress, interspersed with periods of well-being sometimes lasting many weeks. Examination revealed a markedly enlarged duodenal cap and curve. There was an apparent kinking at the ligament of Treitz, or, at any rate, the steep duodenal climb resulted in many ineffectual peristaltic movements in the distal portion of the loop. Superficial observation here would immediately have led all the symptoms to a narrow duodenojejunal flexure. But how could we account for the weeks of well-being? It did not seem possible that an organic obstruction at the Treitz ligament would be present one day and not the next, furthermore examination of the colon showed a very large redundant sigmoid. We felt that the megaduodenum was a congeni-

tal anomaly, just as the sigmoid enlargement was.

Many other causes of obstruction in the duodenum have been listed, including gastroptosis, cecum mobile, peritoneal bands, tumors of the abdomen, and prominent spines. In our cases, we were able to demonstrate only one real pathologic obstruction—a case of carcinoma of the third portion of the duodenum. Bakay (5) reports only 12 cases of pathologic obstruction seen at operation in 10 years of observation. There is an unaccountable difference of opinion which only time will clear up.

One might have expected that surgical experience would have easily solved this problem, by the operation shunting the duodenal contents from the second portion of the duodenum directly into the jejunum. In this connection apparently successful operations have been reported by Griffith (23), Kellogg and McKenty, who are quite enthusiastic. For them the problem seems to be solved. Unfortunately, equally as able surgeons have reported dismal failures. Robertson and Devine (1) and Miller and Gage (10) are convinced that operation has no lasting effect upon the symptoms, which they ascribe to a neuromuscular disturbance. These men attribute the temporary effects to the rest in bed, the proper diet, and the psychologic effect of an operation on a neurotic patient.

We have frequently noted pathologic findings in the duodenum after gastro-enterostomy. In several cases we were able to demonstrate a definite narrowing between the distal and proximal loops adjacent to the new ostium. If surgery were an indication of obstruction, certainly here one ought to find it to a marked degree, yet, much to our surprise it was practically absent. The duodenal loop was considerably dilated and apparently contained a stagnant pool of barium. This was indicative of pathologic stasis and was always associated with nausea, vomiting and other symptoms of dyspep-

sia In these cases, instead of surging, we noted weak, inefficient peristaltic movements and occasional spasmodic hyperperistalsis, just as is seen in cases of obstruction at the pylorus In cases in which gastro-enterostomy had been performed and there were no obstructions, again dilatation was noted The barium gradually collected in the proximal loop, which emptied only partially There was always a moderate degree of pathologic stasis, attributed to lack of vigorous pyloric peristalsis, which, in turn, was due to the shunting of the barium away from the pylorus through the new ostium Here again the dependence of efficient duodenal peristalsis upon similar gastric peristalsis was demonstrated Frequently so little barium passes through the pylorus after gastro-enterostomy that the examiner does not realize the dilatation and pathologic stasis present in the duodenal loop The nausea and vomiting complained of in these cases might easily be due to the bile collected in this loop We have frequently noticed that barium will pass out of the new ostium quickly and then remain quiescent in the jejunum There is no surging, there is no question of obstruction, there is only stasis This again shows the interrelation between gastric and upper intestinal peristalsis

We have frequently seen six-hour retention films shown demonstrating stasis in the duodenal curve This has been interpreted by many as evidence of pathologic motility in the loop, but we cannot confirm that opinion As long as barium remains in the stomach, barium will also be seen in the duodenum In order to diagnose pathologic duodenal stasis roentgenographically, it is necessary to show an absolutely empty stomach, a dilated, filled duodenal curve, and an empty jejunum

We have spent much time in showing that stasis and surging in the duodenum are physiologic except in certain cases of gastro-enterostomy Can we offer any theory for the possible function of these phenomena?

Some observers point to surging as the mixing function of the duodenum (6, 22) It is suggested that food too hurriedly extruded from the stomach is kept in the duodenal loop until it has become well mixed with the gastric secretion (24) This theory does not seem to cover all of the cases How could one account for those in which there is no surging, and why should the asthenic type show the greatest degree?

McWhorter (7) adds a group of cases of duodenal ileus, which he has attributed to hyperthyroidism The tendency to attribute surging to nervous disturbance, and not to mechanical obstruction, is becoming more and more pronounced of late We can only wait for the future to tell us the truth It is our belief that stasis and surging are just the results of the particular type of nervous and postural mechanism This is the only theory that appears to account for most of the findings Dr Singer, in the gastro-intestinal clinic of the Cook County Hospital, in Chicago, has for many years made clinical and x-ray observations of cases showing stasis and surging He also is of the opinion that an actual obstruction does not exist, but he does believe that the symptoms are due to the temporary lowering of the threshold of the sympathetic sensation centers By this he means that certain patients at certain times actually feel the normal duodenal contractions and translate this feeling into pain

We believe that, while such a theory answers many puzzling questions, there is no real proof at present We are not even convinced that the symptoms these patients complain of are referable to the duodenum It is possible that the future will reveal a definite function of this surging but at present all we can say is that it is physiologic and it must not be considered as the cause of symptoms

#### CONCLUSIONS

- 1 Duodenal motility was studied in over two thousand cases

2 Normal hypotonic and hypertonic cases were used as controls

3 Duodenal ulcer, gastric ulcer, and pathologic gall bladder did not affect normal stasis and surging

4 Mechanical obstruction does not account for either the x-ray signs or the clinical symptoms

5 Surgical reports are frequently diametrically opposed

6 The function of surging has not been established. It is believed to be physiologic

7 At present there is insufficient proof for the theory that the symptom-complex is due to the lowering of the threshold of the sympathetic sensation center

8 Stasis and surging are due primarily to the neuromuscular mechanism, and, secondarily, to the mechanical conditions found in different types of patients

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# GIANT-CELL BONE TUMOR

## SOME CONSIDERATIONS OF TREATMENT<sup>1</sup>

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THE neoplasm with which we are to deal needs no elaborate discussion of morphology or classification here. We have shown in a previous communication (1931) the conformity of the original description by Robin and Nelaton with that by Ewing, whom we consider as the authority to-day.

Giant-cell bone tumor is that process which is characterized by a sharply demarcated central tumor of bone in which large multi-nucleated giant cells predominate, either through the whole mass or in scattered masses. The nuclei are centrally placed as distinguished from the foreign-body giant-cell with peripheral nuclei. These cells may enclose blood and cell detritus, bony granules, or lipoid. There are many fine capillaries, and a spindle-celled stroma, sometimes cystic spaces with bloody fluid. Bone formation is not common save at the periphery, and islands of cartilage are found in some. These may be isolated cartilaginous remnants, or fragments of the epiphyseal disc undergoing destruction by the tumor. It is a neoplasm essentially benign, but which, on repeated irritation by surgical or other trauma, may show progressive development of increased cellular proliferation, with perhaps ultimate transition of a part into a true malignant neoplasm capable of dissemination and growth. Further, giant-cell bone tumor in our experience is limited by the epiphyseal disc during the growth period, being found only on the diaphyseal side of that growth area in the long bones, *i.e.*, in the metaphysis. After closure of the epiphysis the neoplasm may invade to the cartilaginous coating of the articulating bone end.

Nelaton demonstrated the probability of regrowth from very small fragments left in the process of a surgical attempt to cure the mass from its bone host.

This is not the place for a discussion of the merits of the belief, held by some observers, that there are certain primary variants of the giant-cell bone tumor which are potentially malignant. We do feel that there is logical probability that, in response to repeated demands for excess reparative activity on the part of the mesoblastic cells of this tumor, growth restraint may be progressively diminished and actual malignant degeneration ensue. In this we again follow the teaching of Ewing, and have reported two cases of malignant degeneration from our own series. It is fully as conceivable that less differentiated bone components should throw off restraint and grow wildly, as that carcinoma cells should arise from what have previously appeared to be well-disciplined epithelial cells.

There is a peculiar coincidence—at least, from the patient's viewpoint—of previous trauma to the part, perhaps minimal in character, or oft-repeated. Thus, one can understand readily the belief of Gross and others that the production of the giant-cell tumor is a reversion of the bone marrow to an embryonal state or is a sequel to the normal response incident upon trauma and repair. And, by a similar process, there may be adequate evidence that the bone proliferation which is common along the septa or trabeculae separating the conglomerate small masses from each other is a repair mechanism. This bone formation unquestionably increases after the increased maturation of the cells following roentgentherapy.

Bloodgood, in an opening paragraph of a discussion of "benign bone cysts, osteitis

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

fibrosa, giant-cell sarcoma, and aneurysm of the long-pipe bones" (1910), made the following statement

"Treatment of tumors which will insure the patient the greatest possibility of a permanent cure with the least mutilation will be accomplished only when surgeons have a better conception of the local growth of neoplasms, both benign and malignant, and are able to diagnose with differentiation the various lesions at the exploratory incision with, *or better without*,<sup>2</sup> the aid of a rapidly frozen section

"This is especially true of bone lesions "

To-day, this carries considerable interest in reference to the problem at hand first, because since that time the nicety of roentgen diagnosis has so developed that, in experienced hands, few bone tumors remain which cannot be allocated to their proper major class by that means. Hence, in large measure the necessity, and definitely the advisability, of exploratory incision is reduced. Second, we are particularly concerned here with the "treatment of tumors which will insure the patient the greatest possibility of a permanent cure with the least mutilation "

A consideration of the treatment of giant cell bone tumor must then take into cognizance that one is to deal with an essentially benign but progressive metaplasia of bone elements. This tumefaction may offer definite danger of disability, if not arrested or eradicated because of the prevalence of involvement of the weight-bearing ends of the long bones. Concurrently radical surgical treatment seeking to eradicate the neoplastic area engenders that mutilation of which Bloodgood spoke.

We have indicated above that one should with rare exception make the diagnosis of this expansile often trabeculated sharply limited tumor of bone by adequate roentgen study. Thus the necessity of surgical approach for diagnosis is obviated. One must consider essentially the method of treatment which will offer the patient the greatest

promise of cessation of growth of the neoplasm and, equally important, the continuance of maximum function.

For the observers before and since Nélaton until the present development of roentgentherapy, the surgical approach was the method of choice. Many, however, have not been fully conscious of the advisability of the thorough curettage of the tumor mass followed by some chemical cauterant at the time of the first incision. The result has often been that there were repeated attempts at surgical removal, the patient suffering considerable disability meanwhile. Occasionally, of course, the surgeon finds it almost impossible to thoroughly curette and yet maintain adequate function, when the lesion is in a major weight-bearing area such as the head of the tibia or lower end of the femur. Further, amputation is a radical procedure which neither surgeon nor patient desires if avoidable.

Roentgentherapy in capable hands, however, has demonstrated its ability to impress upon the giant-cell tumor a certain restraint of growth, with subsequent changes in the area by the attempt of the normal constituents to change the irregular structures into a semblance of normal bone architecture.

This process of "growth restraint" may well be analogous to the changes in the life cycle of the blood cells after roentgentherapy, as demonstrated by Isaacs. If we may consider the bone tumor giant-cell as an osteoclast which has gone a bit wild in its cycle and grows in magnitude by cohesion of two or more we may presumably think of it as a less differentiated or more embryonal unit. Such irradiation should cause it to become more mature, or reach maturity and senescence earlier, with resultant slow but progressive return of the area to a more normal architecture. This process may be indicated to a degree in that in response to irradiation, the giant-cell bone tumor seems to increase in bone mass from three weeks to two months after the initiation of such

treatment. At the end of that time usually, one sees the beginning of a rapidly progressive new bone formation in the formerly osteolytic area. If we have access to the tissue at about one month after roentgentherapy, we find evidence of a marked senescent change in the giant cells. They are shrunken, dehydrated, the nuclei closely packed in the center, the protoplasm granular—many have died and disintegrated, leaving only spaces in the stroma with much scattered chromatin dust. Subsequently the normal bone cell-components build a new bone, almost normal in architecture, upon this empty framework and debris. Further, in support of roentgentherapy, there is the absence of external trauma, which from the cosmetic standpoint is often important.

Also, the older literature is rather full of warning in regard to the prevalence of infection and of hemorrhage in the giant-cell tumor after surgical attack. The infection should not be a barrier to-day, with the perfection of aseptic technic, save in those instances of a focus for growth of a blood-borne infective agent in a traumatized area.

Another point in favor of the irradiation method is the elimination of the factor of hospitalization for surgery and more positive disability for a period.

The recent paper by Simmons in analysis of the cases from the Bone Sarcoma Registry emphasizes the diversity of opinion in the matter of treatment. The unfortunate lack of follow-up material in the form of subsequent roentgenograms makes conclusions from this series inadvisable. It is interesting that in this series irradiation produced a reported clinical cure in from 73 to 75 per cent of the cases in the group curettage together with other agents only from 63 to 72 per cent.

The 19 cases of giant-cell bone tumor in the records of the University Hospital from 1923 to 1931 have been analyzed fully in our previous paper. 14 have been confirmed by histopathologic study. Of the 19, 10 are

TABLE I—GIANT-CELL BONE TUMOR CASES, 1923-1931

Total number of giant cell bone tumor cases by roentgen diagnosis in period.....	19
Number confirmed by microscopic section.....	14
I Recurrences .....	5
Roentgentherapy premature curettage returned for further roentgentherapy five to six months later.....	2
Roentgentherapy premature curettage returned for further therapy 7 months later excision without waiting for irradiation effect .....	1
Curettage recurrence, 6 months referred for roentgen treatment 6 months later symptomatic improvement .....	1
Partial curettage roentgentherapy started patient did not return recurrence or further growth .....	1
II Malignant neoplasm associated with giant cell tumor .....	2
III Clinically cured .....	10
Roentgentherapy only.....	4
Curettage roentgentherapy.....	1
Curettage cauterization (chemical) roentgentherapy .....	4
Excision .....	1
IV Untreated .....	2

considered clinically well. The mode and sequence of treatment are indicated in Table I. Five are considered unfavorable, showing evidence of recurrence either before or after admission to the clinic, two were malignant, and two were untreated in any way. One of these latter patients has since reported in a cursory fashion to a leading hospital and received some roentgentherapy, but has not co-operated with the physicians in charge. Those clinically well, it should be noted, received roentgentherapy, one with curettage, four with curettage and chemical cautery (phenol or acriflavin), and one excision only. Of the recurrences, all showed an irregular program of treatment, either interruption of roentgentherapy by surgery, or roentgentherapy as a last resort after surgery had proved unsatisfactory.

We feel definitely with Herendeen and Pfahler that roentgentherapy offers the best opportunity for control of this type of bone tumor with the least damage to the patient. The voltage to be used depends on the depth and thickness of the tumor. In this series from 120 to 200 P K V has been used with relatively equal success, the filtration being

varied to conform to the best judgment for the quality of the radiation produced by a certain voltage. Divided doses at increasingly longer intervals have been the rule.

#### SUMMARY

1 Giant-cell bone tumor demonstrates a definitely favorable response of the order of "growth restraint," or, earlier maturation and senescence of the tumor cell, under roentgentherapy.

2 Surgical treatment at best does not seem equally satisfactory from the standpoint of control of further growth, minimal trauma to the patient, and minimal disability. When used, it should be accompanied by chemical cauterization of the cavity and adequate roentgentherapy.

3 Roentgentherapy alone is advocated as the method of choice in this type of bone tumor. If surgical attack is advisable from the functional or cosmetic standpoints, it should include chemical cauterization and

associated pre-operative and post-operative roentgentherapy.

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## CHRONIC LYMPHATIC LEUKEMIA INVOLVING THE GASTRO-INTESTINAL TRACT

By CHAKES H. MEAD, M.D. MINNEAPOLIS

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**T**HE literature concerning leukemia and allied diseases of the lymphatic system establishes the impression that any attempt to assign a clinical case to a specific category of the disease is somewhat hazardous. Especially is this true concerning diverse manifestations in various organs. Descriptions of leukemic and aleukemic deposits in the gastro-intestinal tract impress one with their marked similarity and suggest that their differences might well be construed as variations of one fundamental disease.

Accounts of these conditions by various authors have resulted in a chaotic literature, due principally to a lack of standardization

of terminology and classification, the inconsistency of which is especially evident regarding leukemic deposits throughout the gastro-intestinal tract. The extreme variability in terminology associated with the classification of lymphatic tumors has resulted in the suggested use of the word "lymphoblastoma" (31), the term to include the principal neoplastic manifestations of lymphatic leukemia, aleukemia (pseudoleukemia), lymphogranulomatosis (Hodgkin's disease) and lymphosarcoma. The necessity for such an inclusive term illustrates the extreme difficulty of attempting to confine a study to any particular manifestation of lymphoid disease.

Thus, a review of the literature in an attempt to determine the frequency of occurrence of a single type of case becomes extremely difficult. Some idea of the frequency of the condition may be gained from data relative to its occurrence in general autopsy material. Seventy-seven cases of leukemia were found in a recent survey (16) of 12,936 autopsies performed in the Department of Pathology of the University of Minnesota. Fifty-five of the cases were of the lymphatic type and 26 were of the myelogenous type. Two of the lymphatic leukemia cases showed local gastro-intestinal nodular and ulcerative lesions. One of the myelogenous group showed thickening of the walls of the gastro-intestinal tract, without nodule or ulcer formation. Consequently it is probably safe to state that the lymphatic leukemia type of gastro-intestinal lymphoblastoma is quite uncommon. It is for this reason that the following case report is presented.

#### CASE REPORT

The case is that of a white male, 62 years of age, admitted to the University of Minnesota Hospital, June 4, 1929. Death occurred 73 days later.

*History*—The patient had been apparently perfectly well until approximately two years before admission to the University Hospital, when he began to have difficulty in urination. He had trouble in commencing his urinary flow, the stream was small and only small amounts of urine were passed at any time. His condition was neither progressive nor disabling for a period of about one year. In November, 1928, however, he developed frequency and associated nocturia, but noticed neither blood nor cloudiness in his urine.

During November, 1928, the patient's abdomen suddenly became swollen and painful, the pain being dull and aching in character and present over the entire abdomen. His abdomen felt very hard this sensation

being increased by the ingestion of food or fluid. The patient's appetite had been constantly good and his defecations regular, except for a brief period of constipation a short time before admission to the University Hospital.

In February, 1929, he was hospitalized elsewhere, because of his urinary symptoms, and a urinary bladder stone was removed. This procedure failed to relieve his symptoms, and distention of the abdomen persisted. One month before admission to the University Hospital he developed edema of both ankles. The condition remained localized in the ankles, being the same in the morning as in the evening. During the period from November, 1928, to the time of admission to the University Hospital the patient had lost 20 pounds in weight. His chief complaints upon entrance to the University of Minnesota Hospital were those of urinary obstruction, painful enlargement of the abdomen, edema of the ankles, and marked loss of weight and strength.

Past history, marital and family histories were essentially negative.

*Physical Examination*—The patient appeared markedly emaciated, but did not seem to be distressed. His pulse, temperature, and blood pressure were normal.

The abdomen was distended, rounded, and symmetrical in appearance. There was some bulging in both flanks, suggesting the presence of free intraperitoneal fluid. Percussion of the abdomen showed the liver to be about 2 cm. below the costal margins on both sides. There was percussion dullness in both flanks and over a mass in the region of the umbilicus. The mass extended from about 6 cm. above to about 2 cm. below the level of the umbilicus. It also extended to the right and downward from the umbilicus toward the right iliac fossa for a distance of approximately 8 centimeters. The mass was painless, firm, smooth and slightly movable on palpation, changing in shape and size with peristalsis. An inconstant mass,





Fig 1 An anteroposterior roentgenogram, using a barium meal, showing the appearance of the stomach and first portion of the duodenum. The mucosa shows a marked hypertrophy and irregularity from the cardia to the pylorus. The appearance suggests a severe gastritis or a diffuse polypoid. The duodenal bulb has a similar appearance.

thought to be an enlarged spleen, was palpated below the left costal margin.

The posterior cervical, axillary, and epitrochlear lymph nodes were enlarged. Rectal examination showed the prostate gland to be normal and there was no evidence of a rectal shelf. The residual urine, upon catheterization after voiding, was found to be 5 cubic centimeters. The remaining physical findings were normal.

**Laboratory Data**—The urine was normal on repeated examinations except for the presence of numerous pus cells. Examination of the blood revealed: Hemoglobin 53 per cent, red blood cell count 2,610,000, white blood cell count 33,550 differential (polymorphonuclear neutrophils) 13 per cent, (polymorphonuclear eosinophils) 4 per cent, (lymphocytes) 82 per cent, (monocytes) 1 per cent. No immature cell forms were observed. Wassermann was negative. Icterus index 2.5. bromsulphalein liver function test grade 0 liver injury. Gastric analysis: free HCl before and after histamine 0.0 combined HCl before and after histamine 11.0.

**Diagnostic Procedures**—X-ray studies of



Fig 2 A roentgenogram using a barium meal, of the colon. Considerable irregularity of the rectum and sigmoid colon are present, as well as a defect at the base of the cecum. The appearance suggests a pre-diverticular state of the descending colon and hypertrophied mucous membrane of the cecum and rectum.

the chest were made on June 5, 1929. Neither tumor metastasis nor other pathology, except a chronic bronchitis, was demonstrated. On June 6, 1929, a gastro-intestinal study by the ingestion of a barium meal showed an enormously enlarged stomach extending to the right lateral wall of the abdomen and almost down to the pelvis (Fig 1). The mucosa showed a marked hypertrophy and irregularity from the cardia to the pylorus. The appearance suggested a severe gastritis or a diffuse polypoid. In later views enlargement of the rugae was demonstrated to be present chiefly on the anterior wall of the stomach. There was no gastric retention after six hours. The duodenal bulb could not be clearly visualized but the findings were similar to those of the stomach. The opinion at this time was that

the appearance suggested swelling of the mucosa, the individual folds standing out most prominently. This condition was thought to be consistent with an extreme chronic hypertrophic gastritis or polyposis of the stomach. Examination of the pelvic

area of thickened rectal mucosa. Microscopic examination showed it to be normal rectal wall. An enlarged lymph node was removed from the left axilla, histologic study of this structure revealing only a benign lymphoid hyperplasia.

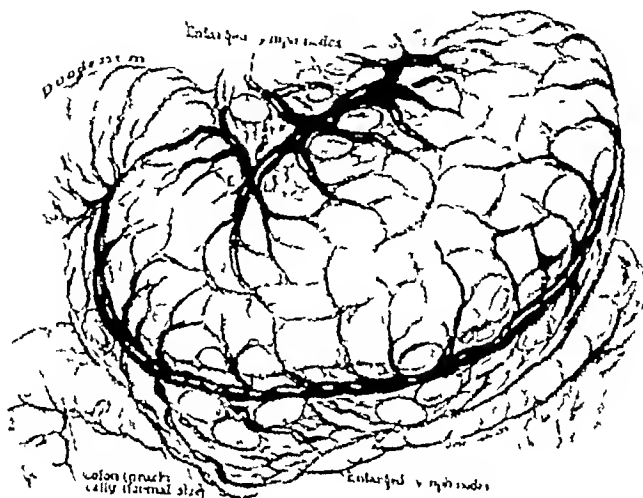


Fig 3 A sketch, illustrating the appearance of the stomach at operation. The stomach presents an appearance of marked lobulation and there is a considerable enlargement of the paragastric lymph nodes. The first portion of the duodenum is seen to be greatly distended, while the colon is apparently normal in size.

bones showed some evidence of lumbosacral and sacro-iliac arthritis but none of tumor metastasis. On June 12, 1929, fluoroscopic and film examinations were made of the colon, using a barium meal (Fig 2). There was considerable irregularity of the rectum and sigmoid colon which suggested a combination of hypertrophied mucous membrane and a pre-diverticular condition of the descending colon. At the base of the cecum there was also evidence of a defect suggestive of a marked hypertrophy of the mucosa. No evidence of other pathology was observed. On the basis of this study a pre-diverticular state of the descending colon and hypertrophied mucous membrane of the cecum and rectum was suspected.

Because of the x-ray findings in the region of the rectum a biopsy was made of an

The patient was in the hospital 17 days before an exploratory laparotomy was performed. An attempt was made to improve his general physical condition during this time for upon admission to the hospital he was much emaciated and consequently was considered a poor operative risk. The patient's appetite was good, and he had no complaints other than that of intermittent dull, aching pain in the lower abdomen. The pulse rate maintained an average of about 90 beats per minute and the temperature was normal.

**Diagnosis.**—The historical data in the case were quite minimal with reference to the gastro-intestinal system. Physical examination, however, had demonstrated in the abdomen a mass which was apparently related to the stomach. There was also a

definite ascites. X-ray examination localized the pathology to the gastro-intestinal system, the most marked findings being in the stomach. Microscopic examination of a rectal biopsy had demonstrated normal rectal wall, and the histology of one of the hy-

Dr O H Wangenstein. A high, right rectus incision was made and when the abdomen was opened the stomach was found to be tremendously dilated and apparently filled with small tumors (Fig 3). Its external appearance was lobular and the vessels

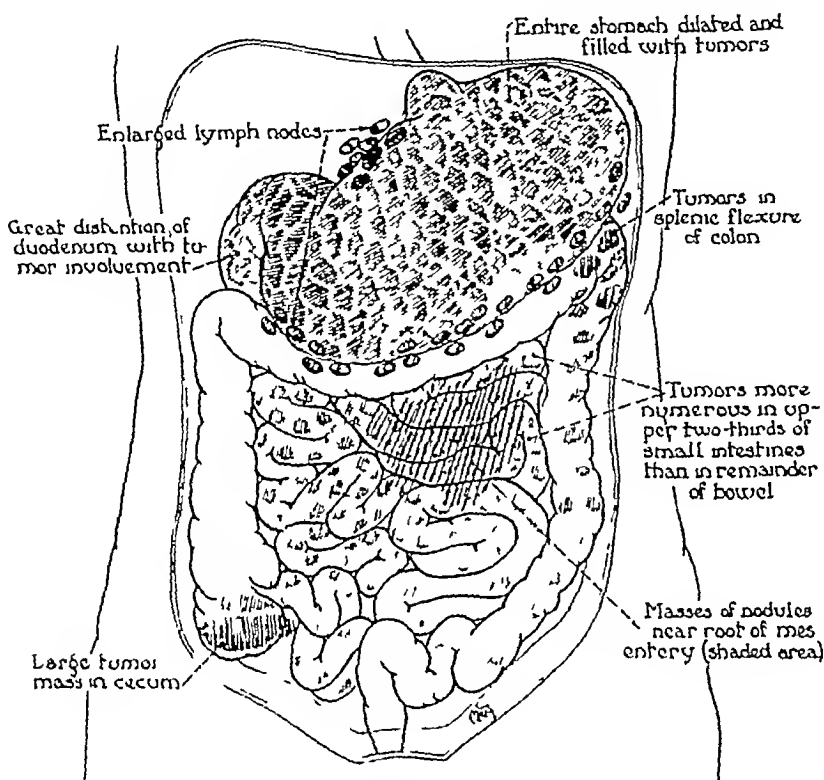


Fig 4. A sketch illustrating the appearance of the entire gastro-intestinal tract *in situ*. The stomach is shown to be dilated and its wall infiltrated with small tumors. The perigastric lymph nodes are enlarged. The duodenum is also infiltrated with small tumors and greatly distended. The entire small bowel is punctuated here and there by small tumors. There is a large cigar-shaped tumor mass in the cecum. Scattered tumor infiltrations are present in the region of the splenic flexure and descending portions of the large bowel.

pertrophied lymph nodes was merely that of lymphoid hyperplasia.

With these considerations in mind but overlooking a significant blood picture because of insufficient co-ordination, a pre-operative clinical diagnosis was made of probable polyposis of the stomach with carcinomatous degeneration. The condition of malignancy was included because of the presence of ascites.

*Therapy*.—Operation was performed under spinal anesthesia on June 22, 1929, by

of the submucous coat shone through around the periphery of what appeared to be a solid mass within the stomach. The enlargement within the stomach extended directly up into the cardiac portion.

The first and second portions of the duodenum were tremendously distended and also contained large tumor masses (Fig 4). The retroperitoneal portion of the duodenum was not examined. From the duodeno-jejunal junction down to the cecum the entire small bowel was punctuated here and

there by small tumors, varying in size, many of which were adherent to the bowel wall. In the cecum there was a large, cigar-shaped tumor mass which seemed to extend through the bowel wall and into the parietes of the right lower quadrant. It was considered possible that this tumor outside the bowel

the stomach. Two of them were excised and microscopic examination demonstrated a definite lymphatic leukemia (Fig 7).

The surgeon deemed it best to close the wound after exploration without performing a jejunostomy for feeding purposes, because of the presence of the large mass in

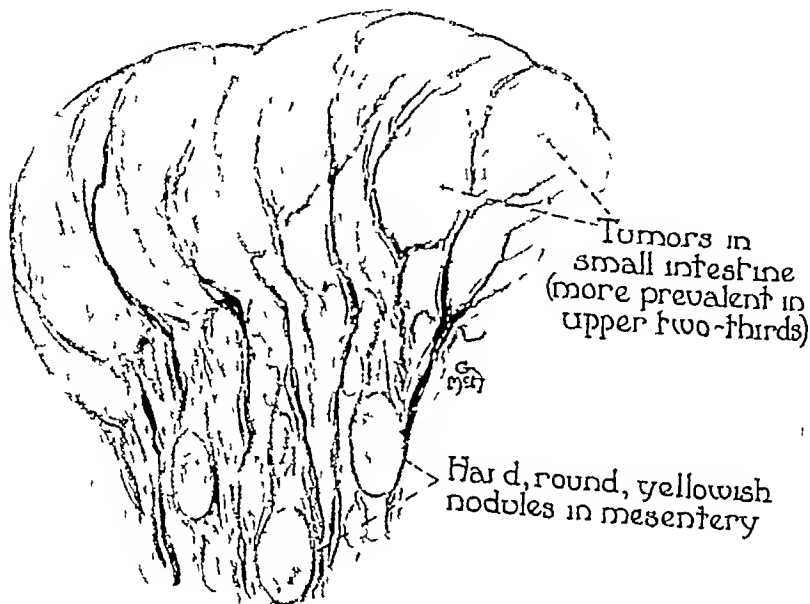


Fig 5 A sketch, illustrating the marked tumor infiltration in the upper two-thirds of the small intestine. A few nodules are present in the mesentery.

might be lymphoid tissue. The location of the incision prevented this differentiation, but on palpation it seemed to be one continuous mass. It was thought that the tumors were much more prevalent in the upper two-thirds of the small intestine than in the lower one-third (Fig 5).

There were three or four similar nodules in the splenic flexure of the colon and a few in the descending colon. The nodules were also present all along the mesentery. There were masses of nodules, many slightly yellowish in color, in the right side of the mesentery of the small intestine (Fig 6). The spleen and liver appeared to be normal. There were a number of large lymph nodes along the greater and lesser curvatures of

the cecum which would undoubtedly have eventuated in obstruction before the patient could take food.

About six weeks after operation a light dosage of deep x-ray therapy was given, but the condition of the patient at no time permitted the necessary heavy dosage.

*Post-operative Course*—The pulse, however, was quite rapid, ranging between 100 and 110 beats per minute. Repeated post-operative blood examinations showed a somewhat constant leukocyte count of approximately 30,000 cells. The presence of immature cell forms was not recorded. The abdominal wound failed to close well, and one month after operation there was little evidence of healing. The patient was also

considerably distended during this time. He became progressively weaker and exitus occurred on August 16, 1929. An autopsy could not be obtained.

#### DISCUSSION

*Etiology*—The variety of lymphatic leu-

Pawlowsky (32), in 1892, isolated causative organisms. Further experimentation at that time was fruitless and Reed (36), in 1902, in summing up the literature to that date, concluded that the condition was due to some poison affecting the bone marrow.

The neoplastic nature of the disease was

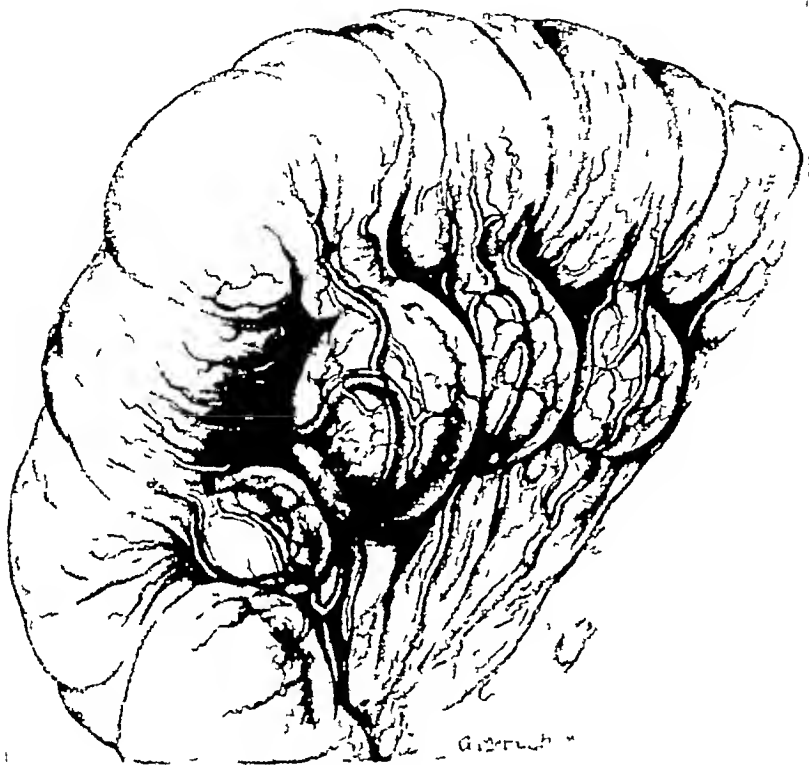


Fig 6 A sketch illustrating the marked invasion of portions of the mesentery by tumor infiltrations

kemia tumor manifestations, as evidenced in the preceding case report and the rarity of the condition have minimized knowledge of the process in entirety. Consequently information regarding the condition is essentially that of lymphatic leukemia. A discussion of lymphatic leukemia deposits throughout the digestive tract necessitates mention of the inflammatory and neoplastic conceptions of the fundamental disease process. Chronologically the first conception was that of the infectious nature and bacteriologic cause of the disease and its manifestations. Kelsch and Vulliamd (22) in 1890 and

first advanced by Babes (1), in 1902. Senator (41) had reported transformation of certain tumors as early as 1882, but these were considered as accidental occurrences of two distinct lesions. Babes (1) was the first to consider all lymphatic leukemias and their manifestations as true neoplastic processes. Stimulated by this idea publications appeared for several years, proving the relationship of lymphatic leukemia and various forms of tumors.

Wirtz's discovery (47), in 1907, of the leukemia of the common toad resulted in the transmission of the disease through sev-

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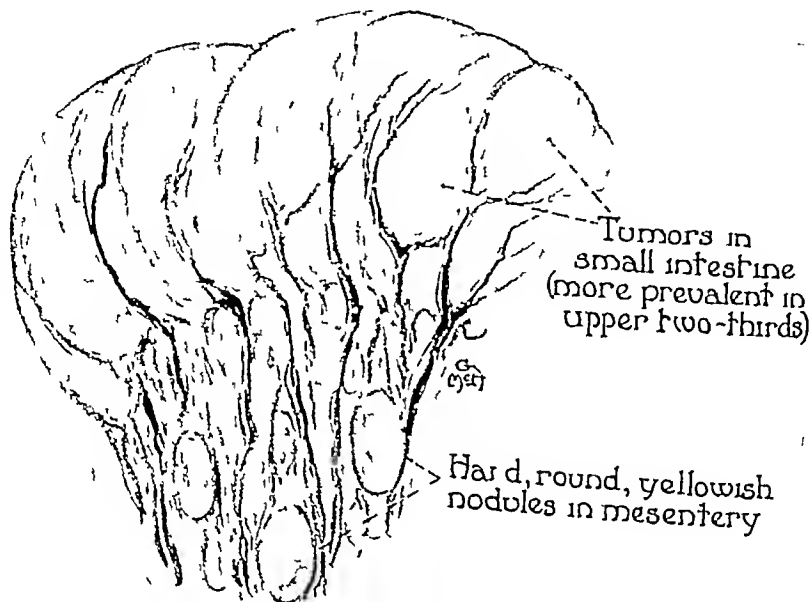


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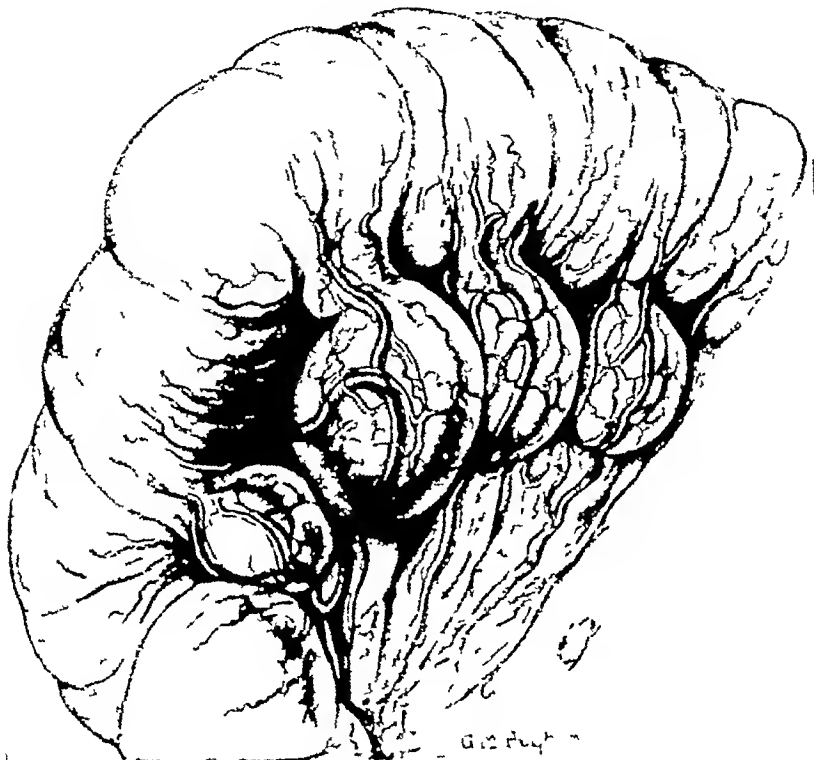


Fig. 6. A sketch illustrating the marked invasion of portions of the mesentery by tumor infiltrations.

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Warthin's discovery (47), in 1907, of the leukemia of the common fowl resulted in the transmission of the disease through sev-

eral generations of the same species and weakened the purely neoplastic conception of the disease

Most of the evidence produced within the past ten years favors the infectious theory. Nevertheless prominent investigators, such



Fig 7 A low power lens view of the typical lymphatic leukemia paragastric lymph node ( $\times 100$ )

as Piney (33) and Lenaz (25), still feel that the condition is neoplastic. Ewing (10) has assumed a middle course and states that the acute forms are probably infectious and the chronic forms neoplastic.

*Lymphatic Leukemia*—Although the occurrence of lymphatic leukemia lymphoblastomas is quite generally recognized, comparatively little is known about their essential pathologic, clinical, and hematologic characteristics. A study of leukemia and leukemic tumors shows that the disease process is composed of many phases of hyperplasia of lymphoid tissue. This case report presents an example of chronic lymphatic leukemia, with a pronounced hyperplastic and neoplastic phase.

Many of the manifestations of this condition are still somewhat vague, especially with reference to those of a neoplastic nature. It is known that the lesions of leu-

kemia, both lymphocytic and myelocytic, involve bone marrow, lymph nodes, spleen, and other pre-existing lymphoid tissues. Heteroplastic growths of lymphoid tissue are seen in the liver, kidney, lung, skin, serous membranes, and many other organs. The chief location of these growths is in the liver, a certain variable distribution of lesions being practically constant in all forms of leukemia. Other organs and tissues, including the alimentary canal, are only occasionally the site of the infiltrations.

As a consequence of the extreme rarity of the condition in the digestive tract, no extensive studies of such pathologic changes have been possible. The disease process, probably essentially the same as that affecting the lymph nodes, results in involvement of chains of nodes and lymph follicles which may remain discrete or become fused. The hypertrophy of the gastro-intestinal lymphoid tissues may result in the formation of bulky tumors. The submucous lymphoid tissue may hypertrophy, with resulting discrete multinodular formations or with ulcerated lesions.

The origin of heteroplastic deposits in the digestive tract or elsewhere is not definitely known. Dominici (9) and Sternberg (43) have concluded that they arise from pre-existing lymphoid structures by hyperplasia. Banti (3), however, feels that the deposits represent metastatic growths of embolic cells.

The presentation of minimal symptoms referable to the gastro-intestinal system is not uncommon in these cases. The symptoms may be merely those of general malaise and loss of appetite with an associated progressive lymphadenopathy. In other cases the symptoms may be primarily those of gastro-intestinal pathology. In these instances the complaints usually consist of abdominal pain with or without relation to meals, nausea and repeated emesis, the development of an abdominal mass, weakness,



and loss of weight. There may or may not be free hydrochloric acid in the stomach contents, and the stools usually do not show evidence of hemorrhage within the intestinal tract. The symptomatology of the condition is not characteristic. It is closely simulated by all of the lymphoblastomatous conditions which affect the digestive tract and cannot be differentiated from them. Furthermore, Singer (42) declares that these symptoms cannot be definitely distinguished from the variable clinical findings of carcinoma of the digestive tract.

The blood picture consists essentially of a progressive anemia and a definite leukocytosis. In the lymphatic type the leukocytic increase is composed predominantly of lymphocytes, in the myelocytic type the number of polymorphonuclear myeloid cells is increased, the cause of the large number of cells in the blood stream being obscure.

The existence of a definite lymphocytic leukocytosis would probably arouse suspicion of the presence of a lymphoblastoma of the intestinal tract. Even this finding, however, cannot be relied upon for diagnostic purposes. For Lannois and Regaud (24), Lucke (28), and Schenk (39) have reported tumors essentially different from leukemia which discharge cells into the blood and simulate it by the production of a lymphocytic or myelocytic leukocytosis.

*Leukemia*—In 1865 Cohnheim (6) applied the term "pseudoleukemia" to a condition anatomically identical with leukemia excepting for a normal blood picture. The term "leukemia" however has been used in recent years in preference to pseudoleukemia. Wunderlich (50) described the condition as a peculiar disease chiefly characterized by a gradual development of numerous swellings of superficial and internal lymph nodes and by peculiar deposits in the internal organs including the gastro-intestinal system.

Leukemia of the digestive system was first mentioned by Briquet (4) in 1835 and

fully described by Stoerk (44) and Symmers (46), who collected 10 cases from the literature. It is generally agreed that deposits in the gastro-intestinal tract are quite uncommon and that they are usually diagnosed by the pathologist. A survey of the literature by Wells and Maver (49) showed the presence of approximately 238 cases of leukemia discovered at autopsy. The gastro-intestinal tract was involved to some degree in 34 of these. The condition was confined to the stomach and intestine in 13 cases, to the stomach alone in seven, and to the intestine in 15 cases. No case of aleukemia of the gastro-intestinal tract was found by the author in a review of 16,254 autopsies performed in the Department of Pathology of the University of Minnesota in the years from 1910 through 1930.

The pathology of the condition, when involving the gastro-intestinal tract, varies from slight swelling of the mucous membrane and lymph follicles to extensive hyperplasia of the lymphoid tissue of the entire alimentary canal. There is also an associated general lymphadenopathy. The process may be limited to a portion, or involve the entire gastro-intestinal tract. When the condition involves the stomach to any appreciable extent the mucosa is thrown into great folds described as simulating cerebral convolutions. Polypoid formations in the stomach and elsewhere in the digestive tract are often present. Ulceration of the mucosa is infrequent, although perforation of a deep ulcer and peritonitis have been reported by Stoerk (44). The muscularis is uniformly uninvolved.

A normal blood picture differentiates the condition from lymphatic leukemia lymphoblastoma. Fwing (10) states that occasionally a relative lymphocytosis is observed but no absolute leukocytosis.

*Lymphogranuloma*—A group of cases formerly classed as aleukemia are now called "lymphogranuloma" or "Hodgkin's disease." The histology of the condition has

eral generations of the same species and weakened the purely neoplastic conception of the disease

Most of the evidence produced within the past ten years favors the infectious theory. Nevertheless, prominent investigators, such



Fig 7 A low power lens view of the typical lymphatic leukemia paragastric lymph node ( $\times 100$ )

as Pincus (33) and Lenaz (25), still feel that the condition is neoplastic. Ewing (10) has assumed a middle course and states that the acute forms are probably infectious and the chronic forms neoplastic.

*Lymphatic Leukemia*—Although the occurrence of lymphatic leukemia lymphoblastomas is quite generally recognized, comparatively little is known about their essential pathologic, clinical, and hematologic characteristics. A study of leukemia and leukemic tumors shows that the disease process is composed of many phases of hyperplasia of lymphoid tissue. This case report presents an example of chronic lymphatic leukemia, with a pronounced hyperplastic and neoplastic phase.

Many of the manifestations of this condition are still somewhat vague, especially with reference to those of a neoplastic nature. It is known that the lesions of leu-

kemia, both lymphocytic and myelocytic, involve bone marrow, lymph nodes, spleen, and other pre-existing lymphoid tissues. Heteroplastic growths of lymphoid tissue are seen in the liver, kidney, lung, skin, serous membranes, and many other organs. The chief location of these growths is in the liver, a certain variable distribution of lesions being practically constant in all forms of leukemia. Other organs and tissues, including the alimentary canal, are only occasionally the site of the infiltrations.

As a consequence of the extreme rarity of the condition in the digestive tract, no extensive studies of such pathologic changes have been possible. The disease process, probably essentially the same as that affecting the lymph nodes, results in involvement of chains of nodes and lymph follicles which may remain discrete or become fused. The hypertrophy of the gastro-intestinal lymphoid tissues may result in the formation of bulky tumors. The submucous lymphoid tissue may hypertrophy, with resulting discrete multinodular formations or with ulcerated lesions.

The origin of heteroplastic deposits in the digestive tract or elsewhere is not definitely known. Dominici (9) and Sternberg (43) have concluded that they arise from pre-existing lymphoid structures by hyperplasia. Banti (3), however, feels that the deposits represent metastatic growths of embolic cells.

The presentation of minimal symptoms referable to the gastro-intestinal system is not uncommon in these cases. The symptoms may be merely those of general malaise and loss of appetite with an associated progressive lymphadenopathy. In other cases the symptoms may be primarily those of gastro-intestinal pathology. In these instances the complaints usually consist of abdominal pain with or without relation to meals, nausea and repeated emesis, the development of an abdominal mass, weakness,

lymph node, was present in the transverse mesocolon. It was removed for histologic study. An anterior gastro-enterostomy was performed to relieve symptoms of gastric obstruction. Microscopic examination of the removed tissue resulted in a diagnosis of lymphosarcoma.

Following a stormy convalescence the patient was given deep roentgentherapy and discharged from the hospital, returning at intervals for further x-ray treatments. His general condition was fairly good until October 12, 1931, when he was again hospitalized because of recurrence of his initial symptoms and complaints. Physical examination disclosed a tender epigastric mass and enlarged inguinal lymph nodes. Laboratory examinations showed a marked secondary anemia, with a relative lymphocytosis. Death resulted from a terminal lobar pneumonia.

Necropsy was performed and a retroduodenal mass was found obstructing the first portion of the duodenum. Neither intrinsic gastric nor duodenal pathology was observed. The cecum and ascending colon showed multiple, umbilicated submucosal nodules measuring from 1 to 2.5 cm in diameter. All of the retroperitoneal abdominal nodes and the superficial and deep inguinal nodes were hypertrophied. The spleen was enlarged and showed multiple tumor-like infiltrations. Microscopic study of the retroduodenal mass and cecal infiltrations resulted in a final diagnosis of Hodgkin's disease, which was in distinct contrast to a previous histologic diagnosis of lymphosarcoma made one year before from an operative biopsy specimen.

The case is of interest as a relative rarity and because it is exemplary of the fallibility in diagnosis of these conditions and the sources of confusion in classification of related disease processes.

*Lymphosarcoma* — Lymphosarcoma was also formerly included with leukemia. The pathology of the condition was first clearly

described by Kundrat (23), however, lymphosarcoma is now recognized as a highly malignant neoplasm arising in lymphoid tissue.

Weeden (48) concluded from a review of reported cases of lymphosarcoma of the intestinal tract that it can no longer be considered as an extremely rare occurrence. Yet it is still so uncommon that isolated case reports are constantly appearing in the literature. Lymphosarcoma involving the gastro-intestinal tract occurred in seven of 16,254 autopsies recorded in the archives of the Minnesota University Pathology Department. This indicates a higher incidence than that of other lymphoblastomatous manifestations. A complete tabulation of reported cases has not been attempted, due to the variation in terminology and because of the many cases reported with partial or no microscopic diagnoses.

The pathologic condition is described as arising from groups of lymph nodes, not single nodes, and from the adenoid tissue of mucous membranes, from which points it extends along submucous tissue or to neighboring nodes and surrounding tissues. Secondary tumors occur almost exclusively in the intestinal mucosa, serous membranes, and lymph nodes and extend by growth through lymph channels. The tumors produce bulky growths which tend to press on the bowel wall from without or result in necrosis and ulceration of mucous membranes from within. Cayley (5) and Kundrat (23) describe the gastric lesions as bulky and diffuse growths about the pylorus or curvatures, and state that it is difficult to determine whether the primary growth is in the wall of the organ or adjacent lymph nodes. They are usually part of a general lymphosarcomatosis, involving the entire gastro-intestinal tract (51). Some gastric tumors produce projecting submucous masses (20) or polypoid and pedunculated formations (34). Ulceration and

been emphasized by Reed (37), and Sternberg (43). Often the initial symptom is an enlargement of chains of lymph nodes, cervical (50 per cent) or otherwise. In from 60 to 70 per cent of cases a splenic enlargement occurs, with an associated cachexia and sharply intermittent type of fever.

Gastro-intestinal lymphogranulomatosis is a rare occurrence. Lymphogranuloma involving the digestive tract was found in three instances in 16,254 autopsies recorded in the Minnesota University Pathology Department. A recent survey (13) of approximately 80 cases of Hodgkin's disease, treated in the roentgentherapy department of the University of Minnesota Hospital, shows only one case with proved involvement of the digestive tract. Gastro-intestinal involvement had been suspected in one other case from clinical findings and symptoms, such as an intra-abdominal mass and the occurrence of gastro-intestinal upsets. Hayden and Apfelbach (14), in reviewing the subject, state that the condition had previously been reported in about 25 cases, in 12 of which the stomach was involved. Singer (42) has recently reported the first case of the condition which was primary and isolated in the stomach. The lesions are usually located in the intestine but may be found in any portion of the digestive tract. Hodgkin's disease is difficult to separate pathologically from tuberculosis (40) and lymphosarcoma (10). Coupland (7), Kaznelson (21), Singer (42), Sussig (45) and others have described typical cases but the literature is scanty, as most cases are classified with lymphosarcoma.

The pathologic picture varies from small thickened areas of mucosa to large, infiltrative, ulcerating lesions which sometime result in perforation of the bowel wall. Ulceration occurs quite frequently and, in contrast to tuberculosis, is present in the upper digestive tract. It is stated (15) that the ulcerative lesions cannot be differentiated from carcinoma except by microscopic

study. Obstruction of the bowel in this condition is relatively uncommon.

The blood picture is usually normal except for a prevailing relative lymphocytosis. There is usually no leukocytosis.

The following brief report illustrates a case of this type recently encountered on the surgical service at the University of Minnesota Hospital. A white male, 67 years of age, was first admitted to the University Hospital on September 2, 1930. He complained principally of a sensation of fullness of the stomach, a mass in the region of the stomach, emesis of solid foods, constipation, a recent loss of 20 pounds in weight, and generalized weakness. These symptoms had commenced in July, 1930, and had developed more or less in the sequence listed above.

Physical examination demonstrated a firm, movable, slightly tender mass, measuring approximately 10 cm in diameter, in the midepigastrium. The mass moved with respiration and could not be definitely separated from the liver margin. A smaller mass about 2 cm in diameter below and to the right of the large epigastric mass was found to move freely from side to side and with the diaphragmatic excursion.

Laboratory examination of the urine and blood showed them to be normal. Gastric and stool analyses and blood chemistry tests were normal. X-ray examination of the gastro-intestinal tract favored a diagnosis of carcinoma of the stomach, although possible pressure on the stomach from an extra-gastric mass was considered.

With a pre-operative diagnosis of carcinoma of the stomach, exploratory laparotomy was performed by Dr. O. H. Wangenstein. The stomach and duodenum were found to be normal, but displaced upward and forward by a large mass of lymph nodes which were closely matted together. Another mass about 4 cm in diameter, which on gross section appeared to be a

and irradiation, shows that the results of surgery alone are better than irradiation alone, and that the greatest therapeutic benefit is derived from a combination of these methods. Evaluation of methods of treatment of lymphoblastomas of the digestive tract must, necessarily, be based upon the results derived from the treatment of the most common type of lesion encountered, namely, lymphosarcoma. The literature in this regard indicates that treatment has been primarily surgical, irradiation being secondary. The diagnosis of the condition has usually been inaccurate, practically every case being considered carcinoma, consequently, surgical treatment has been employed. Furthermore, in many cases the diagnosis has not been clear and surgery has been utilized as a diagnostic procedure. For these reasons surgical therapy has predominated. When the true nature of the condition has been recognized, however, roentgentherapy has been recommended almost invariably as a secondary therapeutic measure.

These considerations must separate a very small group of cases, in which the diagnosis is made pre-operatively and the tumor is apparently resectable, from a much larger group of cases in which the diagnosis is made only at operation. Crumston (8), Rankin (35), and Weeden (48) state that opinion regarding treatment of the first group is not unanimous but that surgical excision of the lesions is most frequently recommended. There is practically unanimity of opinion that surgical resection should be performed in the second and larger group of cases. It is generally agreed that roentgentherapy post operatively is constantly valuable.

No detailed analysis of the results of treatment of leukemia, leukemoid or Hodgkin's disease of the intestinal tract has been possible because of the relative rarity of these cases in the literature. Lymphosarcoma, however, has been more frequently encoun-

tered among neoplasms of the digestive system, and some specific data regarding results of treatment have been obtained. Liu (27) reported 12 cases involving the small intestine, with no immediate operative mortality. Five cases died three months post-operatively, four cases lived from 1.5 to 6 years after operation, and three cases were living five years after operation, without recurrences. Weeden (48) reported 10 cases with involvement of the small intestine, seven of which died within one year after operation, one within 2.5 years, and one within 3.5 years after operation.

Kapel (19) collected and reported a series of 60 cases of lymphosarcoma of the stomach. Resection was performed, with an immediate mortality of 18 per cent. He reported three cases of the group living 8, 9, and 15 years post-operatively, without recurrences. Minot and Isaacs (31) reported lymphosarcoma of the stomach, in one case that lived seven years after operation, and Weeden (48) reported one case with involvement of the stomach, that was well nine years after gastric resection. Balfour and McCann (2) reported sarcoma of the stomach in 54 cases, 32 of which were lymphosarcoma. Fifty-three of the cases were operated upon, with an immediate mortality of 11.3 per cent. Direct operative procedures upon the stomach in 38 cases resulted in a 13.5 per cent immediate mortality. The average post-operative length of life after simple abdominal exploration was four months and after gastric resection, 11 months. Twelve cases were reported to be living five years and one case nine years after operation with no clinical evidences of recurrence.

The results of surgical treatment of lymphosarcoma of the gastro-intestinal tract are encouraging. One may conclude that surgical treatment is justified for the various types of lymphoblastomas of the digestive system.

pyloric stenosis are frequent. In the intestine the tumors are most common in the lower ileum but may appear at any point. Rectal (11) tumors are the least frequent. The appendix (17) may be a primary site and present an acute (26) picture. The early stages of these lesions appear as thickenings of the submucosa with or without ulceration. Polypoid growths and subserous tumors appear later. Ulceration, perforation, and peritonitis may occur.

The blood picture is usually normal except for polymorphonuclear neutrophilic leukocytosis which is usually present. Occasionally the picture resembles leukemia, and the differentiation between these conditions cannot always be sharply drawn (29).

The preceding brief survey of the salient characteristics of lymphoblastomas affecting the gastro-intestinal tract emphasizes their marked similarity. Their occurrence, excepting lymphosarcoma, has been so infrequent in the literature that further recording of isolated cases may be considered justifiable. Since lymphosarcoma may no longer be considered a rarity among lesions of the gastro-intestinal tract, it may consequently assume an important diagnostic significance. Notwithstanding the stated infrequency of occurrence of lymphoblastomas of the digestive tract, more than 250 cases have been reported (12). Furthermore, they are considered to be the most common tumors of the small intestine (27), occurring three times as often as carcinoma. Consequently, these lesions deserve constant consideration in the differential diagnosis of tumors of the alimentary canal.

The gross pathologic<sup>1</sup> appearance of these conditions suggests that they are essentially normal variations of a fundamental disease process. The symptomatology of lymphoblastomas of the digestive tract is not char-

acteristic. The symptoms do not permit accurate and constant differentiation (15) of the condition from carcinoma or other tumor formations of the gastro-intestinal tract. Therefore, it may be concluded that the symptoms are simply those of gastro-intestinal neoplastic processes.

The hematologic findings in these allied conditions tend to show some differential points. Yet it is stated (10) for each of the conditions that there are occasions when no clear hematologic demarcation is possible. Furthermore, there are accumulating records of neoplastic processes, such as carcinoma of the uterus (24), spindle cell sarcoma of the axilla (28), and carcinoma of the stomach (39), which have produced blood pictures paralleling those of the lymphoblastomas. This would suggest a non-specific reticulo-endothelial reaction to neoplasms in general.

It is clear that the differential diagnosis of these conditions cannot be made with assurance upon a basis of clinical findings. The development of roentgenographic examination of the body has been of inestimable aid in general diagnosis. Holmes, Dresser, and Camp (15), Junghagen (18), and Ruggles and Stone (38), agree from their studies, however, that roentgenologic aid in the accurate differential diagnosis of lymphoblastomas of the alimentary canal has been minimal, for most of the lesions have been diagnosed as carcinoma. They have rarely been correctly diagnosed roentgenologically, and only after careful study of the clinical and laboratory findings. The failure in diagnosis of the condition is probably due to the fact that most roentgenologists see only one or a few isolated cases. More extensive roentgenologic experience with the condition will no doubt result in more general recognition of it.

*Treatment*—Minot and Isaacs' (31) extensive analysis of results of treatment of lymphoblastomas in general, by surgery

<sup>1</sup>The author is indebted to Dr. E. T. Bell and Dr. W. A. O'Brien of the University of Minnesota Pathology Department for confirmation of statements and opinions concerning the gross pathology of the conditions described.

and irradiation, shows that the results of surgery alone are better than irradiation alone, and that the greatest therapeutic benefit is derived from a combination of these methods. Evaluation of methods of treatment of lymphoblastomas of the digestive tract must, necessarily, be based upon the results derived from the treatment of the most common type of lesion encountered, namely, lymphosarcoma. The literature in this regard indicates that treatment has been primarily surgical, irradiation being secondary. The diagnosis of the condition has usually been inaccurate, practically every case being considered carcinoma, consequently, surgical treatment has been employed. Furthermore, in many cases the diagnosis has not been clear and surgery has been utilized as a diagnostic procedure. For these reasons surgical therapy has predominated. When the true nature of the condition has been recognized, however, roentgenotherapy has been recommended almost invariably as a secondary therapeutic measure.

These considerations must separate a very small group of cases, in which the diagnosis is made pre-operatively and the tumor is apparently resectable, from a much larger group of cases in which the diagnosis is made only at operation. Crumston (8), Rankin (35), and Weeden (48) state that opinion regarding treatment of the first group is not unanimous, but that surgical excision of the lesions is most frequently recommended. There is practically unanimity of opinion that surgical resection should be performed in the second and larger group of cases. It is generally agreed that roentgenotherapy post-operatively is constantly valuable.

No detailed analysis of the results of treatment of leukemia, leukemia or Hodgkin's disease of the intestinal tract has been possible because of the relative rarity of these cases in the literature. Lymphosarcoma, however has been more frequently encountered

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The results of surgical treatment of lymphosarcoma of the gastro-intestinal tract are encouraging. One may conclude that surgical treatment is justified for the various types of lymphoblastomas of the digestive system.

## SUMMARY AND CONCLUSIONS

1 Chronic lymphatic leukemia involving the gastro-intestinal tract occurs very infrequently

2 All tumors of the digestive tract arising in lymphoid tissue are relatively rare occurrences Lymphosarcoma is the most frequently encountered tumor of this group

3 Comparisons of the gastro-intestinal manifestations of leukemia, aleukemia, lymphogranulomatosis, and lymphosarcomatosis show a marked clinical, pathologic, and hematologic similarity

4 None of the diagnostic features of these conditions is characteristic Because these conditions usually cannot be differentiated from carcinoma of the intestinal tract, they assume an important differential diagnostic significance

5 Accurate diagnosis depends principally upon a careful correlation of the clinical x-ray and laboratory findings

6 The combination of surgical treatment and roentgentherapy has been shown to offer the greatest therapeutic benefit in the treatment of lymphoblastomas in general

7 Intestinal resection, in a small series of cases, has shown no immediate operative mortality Gastric resection, in two relatively small series of cases has shown an immediate operative mortality of approximately 15 per cent

8 The average duration of life after gastro-intestinal resection has been approximately one year, however a considerable number of five-year cures have been reported Isolated cases are reported living as long as eight, nine and 15 years after operation without recurrences

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## PROGRESS IN THE DESIGN AND MANUFACTURE OF X-RAY TUBES

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THE purpose of this paper is to present some of the factors that have been of importance in recent x-ray tube design and manufacture. To some extent it is a survey of the present status of knowledge about x-ray tubes with particular reference to progress of the last few years and factors not generally understood. In the attempt to explain briefly involved problems in the field of physics and engineering a certain lack of clarity in some cases is

probably unavoidable. It, however, enough clearness can be obtained to convey any appreciable amount of stimulation or value the paper will have served its function.

### PART I DESIGN

#### 1. Physical Dimensions

The dimensions of an x-ray tube are determined largely by the voltage at which it is to be operated. Provision must be made

for the high electrostatic stresses accompanying the voltage, and also for the high velocity electrons made possible by the high voltage and essential in the production of  $\gamma$ -rays. It is significant that high velocity electrons are sought deliberately in no other

The arms serve the following purposes (1) Give an overall length in conjunction with the bulb sufficient to prevent spark-over the outside of the tube, (2) give a convenient support for the electrodes, (3) prevent any appreciable number of stray elec-

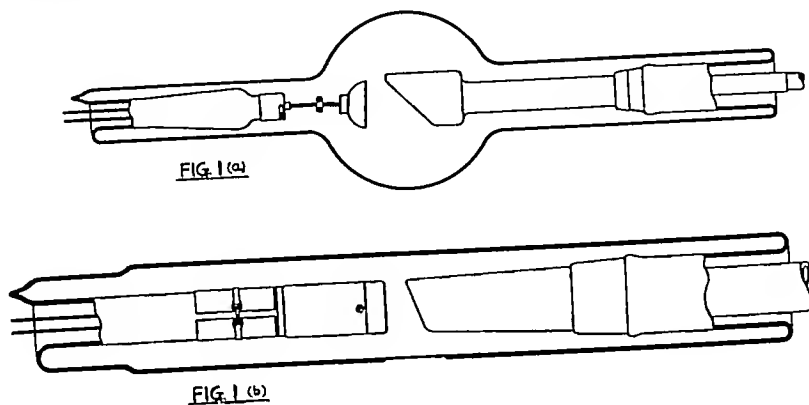


Fig 1 Comparative drawings of two types of diagnostic  $\gamma$ -ray tubes (A) Soft glass tube, rated 85 KVP, tested at 110 KVP, used with lead glass bowl for  $\gamma$ -ray protection (B) Hard glass tube, rated 110 KVP, tested at 130 KVP, used with cover shown in Figure 2 for  $\gamma$ -ray protection

vacuum device, with the exception of the cathode ray tube. Hence,  $\gamma$ -ray tubes present problems not found in other vacuum devices. The electrons must be accelerated, focussed, stopped, and resultant heat dissipated. In hitting the focal spot many are not completely stopped, but bounce off with a lower velocity to be attracted to other portions of the tube, such as the envelope, anode shank, and anode arm.

The conventional shape of the hot cathode  $\gamma$ -ray tube envelope is a spherical bulb having two cylindrical extensions called the anode and the cathode arm (Fig 1-1)

TABLE I

Maximum allowable pressures of various gases for good tube operation at 85 KVP 30 ma, of tube shown in Fig 1-1

Helium	5 0 to 10 0 microns
Hydrogen	4 0 to 8 0 microns
Nitrogen	0 5 to 1 0 micron
Water Vapor	0 2 to 0 5 micron
Mercury Vapor	0 01 to 0 03 micron

trons, or positive ions, from getting on the glass near either end of the tube.

The last purpose is very important and a consideration of it enters into almost every tube design. The inside surface of the glass envelope near each end of the tube must be relatively free from stray electrons in order to prevent rapid leakage of their negative charge to positive potential, heating of the glass, sparking over its surface and resulting disturbances in general. This is prevented by the arms because of their relatively long length compared with the constricted space between their inside surfaces. It is possible to prevent stray electrons from getting to any portion of the envelope by means of a design in which the electrons are trapped in a hollow anode. In this case constricted arms are not necessary. Such a design, however, has found little application except for high voltages (4) since in most cases it is complicated and there is little to be gained over the usual design.

The bulb on the other hand with its

larger surface and greater spacing to the electrodes does the following

1 Gives a large radiating surface for heat, which is of particular importance with a solid tungsten anode cooled by radiation through the bulb, as, for example, in the universal and air-cooled therapy tubes

shape are satisfied For the purpose of analysis the cylindrical envelope can be considered as a special case of bulb plus two arms in which the arms are of the same diameter as the bulb Its electrode design must be such that the envelope is "filled up" for a considerable distance at each end of

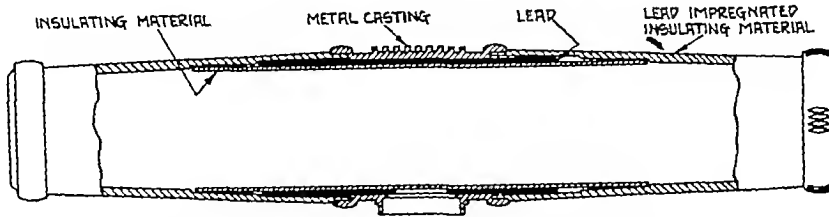


Fig 2 Section of a removable x-ray protecting cover for tube shown in Figure 1-B

2 Gives a large surface for deposit of sputtered or melted metals from the electrodes

3 Keeps the glass out of the strongest portion of the electrostatic field between the anode and cathode so that disturbances due to high potential gradients in the glass are prevented

A method adopted by several European manufacturers (11) for eliminating the third consideration is to make the central portion of the envelope out of metal or to shield the glass by means of metallic shields Experiments with glass in the last few years, however, have shown that in many cases without going to this complication the size of the bulb can be made smaller than was previously thought possible This is due, in part at least, to more heat-resistant, higher dielectric strength, hard glasses now available such as for instance pyrex

*1 straight cylindrical envelope* rather than a bulb plus two arms is sometimes desirable because x-ray protection can be placed around it more readily It has proved to be a practical shape in those cases in which by proper internal electrode design and glass selection the requirements listed under the older envelope of conventional

the tube to produce the effect of constricted arms, and, on the other hand, such as to give sufficient spacing to the envelope at the central, or bulb, portion of the tube

In the cylindrical envelope tube illustrated in Figure 1-B advantage is taken of the requirements as to electrode design to obtain a maximum heat capacity in the anode and x-ray protection in the cathode The removable cover for this tube (Fig 2) has several functions besides providing x-ray protection Its construction is such that the tube is surrounded by an envelope of insulating material and, therefore, protected against puncture to external objects even though they are grounded and touch the outside of the cover In case of overload and abuse of the tube, the cover allows the deposit of a greater amount of sputtered or melted metal on the glass envelope than would be the case if the tube were operated alone The reason is that the metallic lead sleeve incorporated in the center of the cover, although primarily for x-ray protection, also acts as a condenser in conjunction with the tube electrodes to reduce longitudinal electrostatic stresses on the glass Although without the cover these stresses would cause no harm to the glass, they might cause disturbances

over the surface of any metallic film on it and thus seriously affect tube operation

*Electrode Spacing*—The minimum spacing between electrodes inside of an x-ray tube has been found to be a very definite function of the voltage at which the tube is

electrode spacing. Also from the standpoint of x-ray protection the greater the spacing the more direct radiation must be intercepted by lead around the tube

## 2 Glass

Glass is used as an insulation and en-



Fig 3 Process of grinding a section of an 80 mil thick pyrex cylinder to a 15-mil thickness in order to serve as a low absorption window for x-rays

to be operated. Too close a spacing results in voltage surging and erratic operation due to cold cathode discharges. Because these discharges are not focussed they are also likely to liberate gas and cause permanent injury. In general, clean, smooth, rounded surfaces stand a somewhat higher voltage for a given spacing without showing this type of disturbance.

A spacing larger than is necessary from a voltage standpoint, on the other hand, increases the difficulty of obtaining good focal spot distribution for the reason that the surrounding negatively charged envelope has a distorting influence on the electron stream, the magnitude of which increases with the

envelope material in practically all partial or high vacuum tubes. The reasons for this are many. It is easily fabricated, is vacuum tight, can be degassed with relative ease, has a relatively high melting point, is a good insulator, and is transparent. There are many compositions of glass having widely different properties. The properties that are of particular importance in an x-ray tube are high dielectric strength, high melting point, high electrical resistivity, and low x-ray absorption.

*Hard Glass*—In the past soft glasses of sodium or cerium base have been used most frequently. Within the last few years a considerable amount of experimental work has

been done with boro-silicate hard glass. Its higher melting point, greater mechanical strength, and higher electrical resistivity than soft glass make possible, in some cases, tube designs that would be impractical with the older glass. In spite of the fact that it

ground down to a thickness less than one-half that of the remaining portion of the envelope (Fig. 3). This is done to reduce the filtering action of the glass to a definite minimum value and at the same time obtain the ruggedness of heavier glass. In therapy

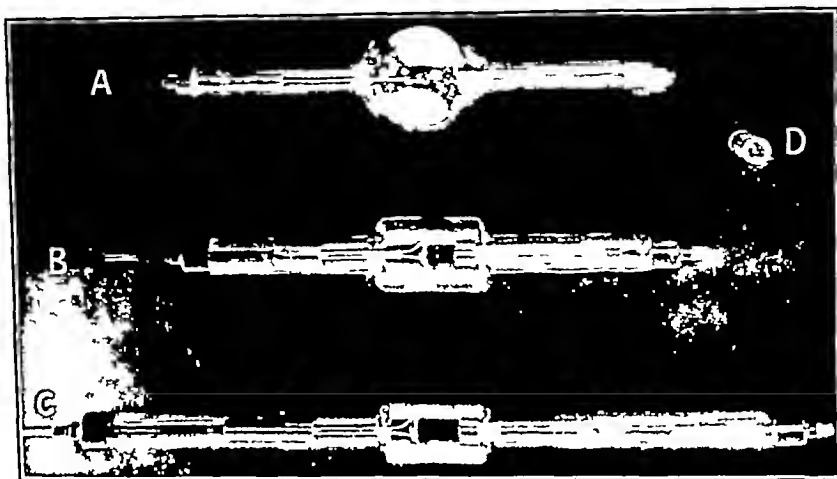


Fig. 4 Thick pyrex glass therapy tubes (A) Air-cooled tube rated 200 KVP, 6 ma, tested 240 KVP (B) Water-cooled tube rated 220 KVP, 30 ma, tested 250 KVP (C) Water-cooled tube, rated 300 KVP, 10 ma, tested 340 KVP (D) Cross section of arm of therapy tube showing one-quarter inch glass thickness

is more expensive and harder to work into the required shapes it is being used in most of the new tubes and is replacing soft glass in some of the older ones.

*Thickness of Glass*—As has already been pointed out, in most tube designs the inside surface of the glass envelope receives a negative charge from stray electrons. Because of the charge there is a difference in potential between the inner and outer surfaces of the glass. The walls of the envelope must have sufficient dielectric strength (that is thickness) to withstand this difference in potential which largely depends upon the voltage at which the tube is being operated. In diagnostic tubes considerations of mechanical strength and manufacture usually result in a thickness of more than enough to take care of the voltage. In one new diagnostic tube the portion of the envelope through which the useful beam of x-rays emerge is

tubes operating at higher voltages, however, experience has shown that in most cases the thickness must be deliberately increased or failure by puncture will occur. It has been found practical to fabricate hard glass tubes with a one-quarter inch thickness envelope (Fig. 4). Splices in the glass, bubbles or lines, and the exhaust tubulation all have a lower dielectric strength than solid glass and must be carefully controlled. It has been found best in high voltage tubes to remove the exhaust tubulation from the center of the bulb to the cathode end of the tube.

*Glass Fluorescence*—Glass like a great many other substances when bombarded by electrons of certain velocities, gives off a glow or fluorescence of characteristic color. An analogous phenomenon is the well-known fluorescence produced on screens of calcium tungstate crystals when exposed to x-rays. Portions of the glass in an x-ray tube may

be subjected to enough bombardment by stray electrons to give a readily visible fluorescence of this kind. It is often mistaken as an indication of gas. Glow due to low pressure gaseous ionization takes place

inspection this may seem to be the case. It is of a characteristic color, depending upon the composition of the glass—green for lime glass and blue for most of the hard glasses—and is most pronounced in an x-ray tube

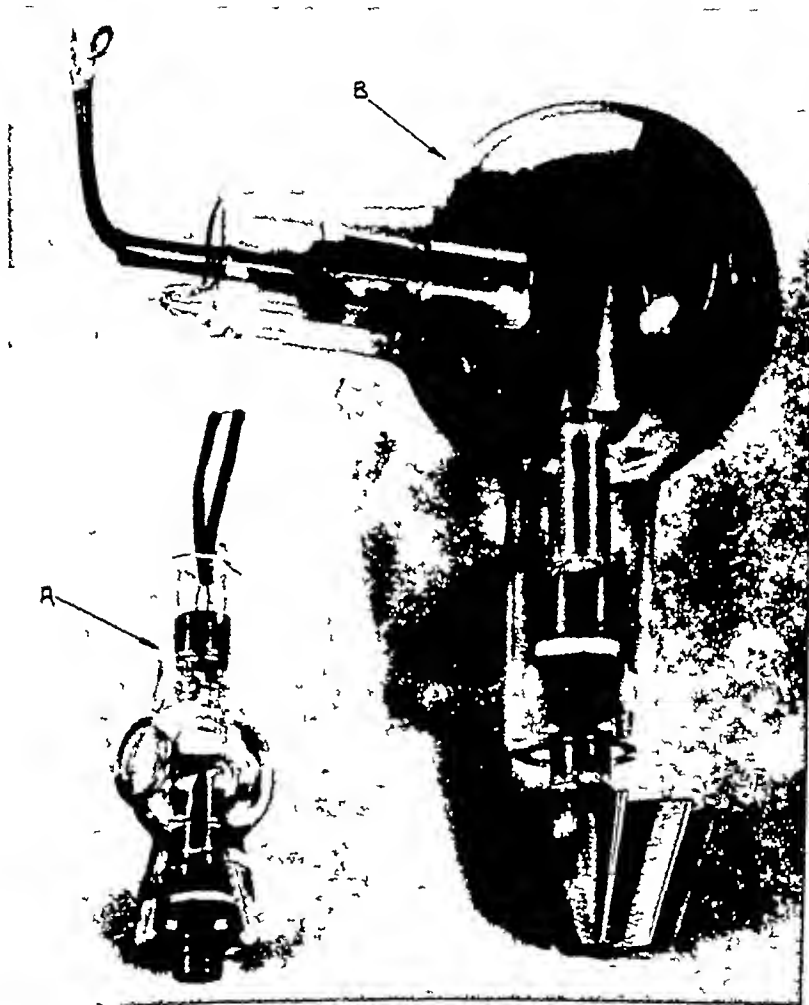


Fig 5 Oil-immersed tubes. (A) Lead glass tube rated 68 K V P, self-rectified, 10 ma. (B) Hard glass tube rated 85 K V P, useful (100 K V P inverse) self-rectified 30 ma. A slightly modified form of this tube was the first tube to be manufactured in hard glass.

throughout the space occupied by the ionized gas and the color depends upon the gas (pink for nitrogen, blue for oxygen). Fluorescence, on the other hand, takes place only at the surface of the glass under bombardment and does not extend throughout the whole cross-section of the space, although on casual

when operating at the lower voltages, such as 30 to 60 kilovolts peak. Possibly at these low voltages the amount of bombardment is greater than at higher K V P because the electrons can get farther into the anode arm and thus decrease the leakage path. As a matter of fact most tubes do not show any

fluorescence at 100 K V P or more, but practically every tube will show fluorescence at the lower voltages

In itself, fluorescence does no harm In those cases in which it is caused by high

the filament and mainly due to pure thermionic emission, although there is always a slight amount of ionization by collision and positive ion current for the reason that a perfect vacuum is impossible to attain

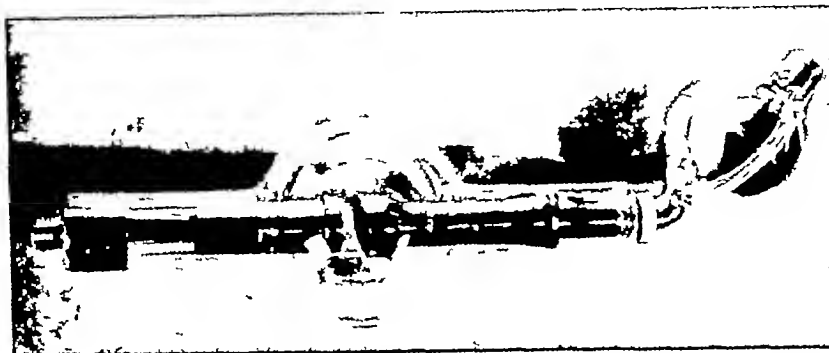


Fig 6 Highest power radiographic tube, rated 85 K V P, 1,000 ma, 1/30 second or 50 K V P, 500 ma., 1/2 second, and capable of handling 2,000 of these exposures in one 8-hour day

velocity electrons it may indicate and be accompanied by considerable heat which must be taken into consideration in tube design so that overheating of the glass does not occur It is also one of the factors in oil-immersed tube design that makes possible shorter anode arm and smaller bulb construction because, with oil cooling of the glass, more fluorescence and heat can be allowed (Fig 5)

### 3 Gas

The gas pressure in a hot cathode x-ray tube must be below that which gives spontaneous or cumulative ionization (3, 6) This is necessary in order that the electron flow to the focal spot may be controlled exclusively by the temperature of the hot filament By cumulative ionization is meant ionization which, starting with a few ionized atoms spontaneously causes ionization of a great number With a pressure sufficient to give cumulative ionization the electron flow cannot be controlled, and gaseous discharges between the electrodes and other parts of the tube take place with resulting runaway additional gas liberation glass heating and possible failure With a gas pressure below this critical value the flow is controllable by

The critical pressure at which cumulative ionization starts is a function of the tube geometry, voltage that is applied to the tube, and type of gas involved It varies between wide limits for different gasses as is shown in Table I

In general there is no advantage to be gained by deliberately leaving a residual gas pressure As high a vacuum as possible is desirable in order to have a margin of safety in case gas is liberated during the life of the tube Gases such as oxygen, nitrogen, water vapor, and mercury vapor are particularly undesirable because of the instability of their action, especially in reacting with a hot filament to poison the electron emission (14)

### 4 Focal Spot Considerations

*Wrought tungsten* has little competition as a target material since it has to a greater extent than any other material the desirable qualities for this purpose, namely, high atomic number, high melting point, good heat conductivity, and low vapor pressure It can be bombarded with an energy that raises its temperature to more than 2,700 degrees centigrade This makes possible an energy of bombardment for one second of

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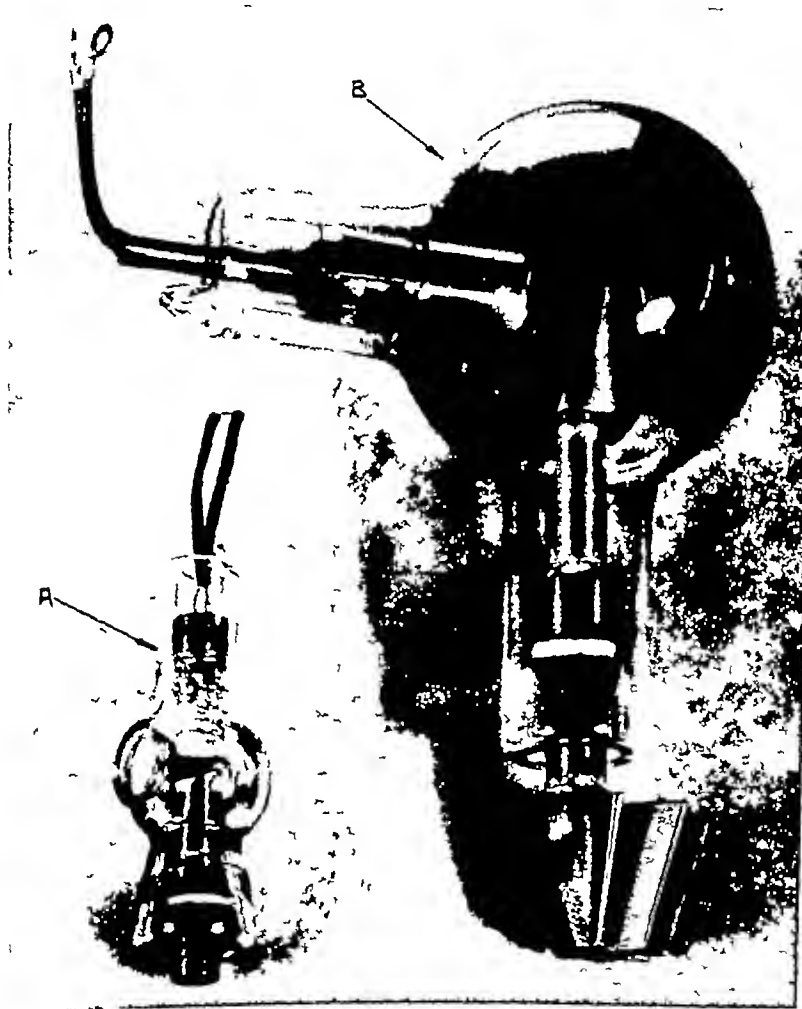


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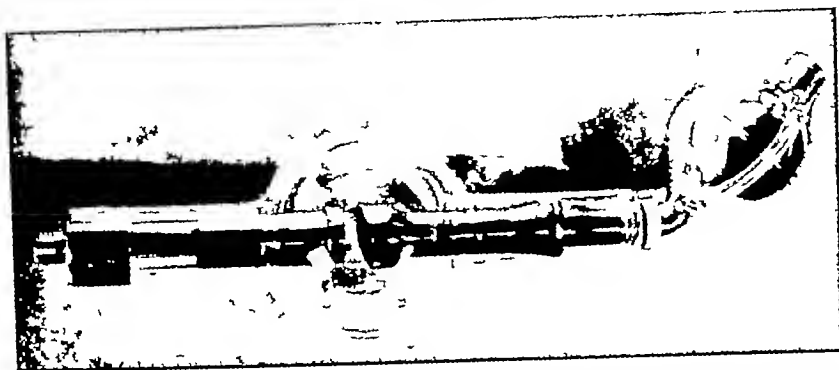


Fig 6 Highest power radiographic tube, rated 85 K V P, 1,000 ma., 1/30 second or 50 K V P, 500 ma., 1/2 second, and capable of handling 2,000 of these exposures in one 8-hour day

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TABLE II—COMPARISON OF FOCAL SPOT DESIGNS WITH RESPECT TO INFLUENCE ON RADIOGRAPHIC FACTORS

All factors expressed in arbitrary units unless otherwise stated						
Focal Spot Design		Distance (of Focal Spot to Part Radiographed)	Detail (for a Given Part—Film Distance)	Radiog Speed (b)	Maximum Allowable Film Dimension (c)	Power Required
Area of Impact (a)	Angle (with Respect to a Line Normal to Film) $\phi$	d	$D = 707d$ $\sin \phi \sqrt{a}$	$v = \frac{a}{d^2}$	$L = d \tan \phi$	$p = a$
1 0	45°	1 0	1 0	1 0	1 0	1 0
4 0	45°	1 0	0 50 (poorer)	4 0 (faster)	1 0	4 0
4 0	45°	2 0	1 0	1 0	2 0	4 0
1 0	20°	1 0	2 1 (better)	1 0	0 36	1 0
4 3	20°	1 0	1 0	4 3	0 36	4 3
7 6	20°	2 75	2 1	1 0	1 0	7 6
1 0	10°	1 0	4 1 (better)	1 0	0 18	1 0
16 5	10°	1 0	1 0	16 5	0 18	16 5
33 0	10°	5 7	4 1	1 0	1 00	33 0
1 0	90°	1 0	0 71 (poorer)	1 0	large	1 0
0 5	90°	1 0	1 0	0 50 (slower)	large	0 50

(a) In all cases it is assumed that the shape of the area of impact is such that its projection on the film is a circle

(b) It is assumed that radiographic speed is a function of area of impact and tube-part distance. This is true only for short exposures in which area of impact rather than heat conduction from the focal spot is the controlling factor in determining the maximum allowable tube power

(c) This comparison holds assuming either that the film size is limited by difference in detail over the film or by the actual size of the useful beam of x-rays

approximately 250 watts per square millimeter when the tungsten is in the shape of a thin 100 mill disc backed by a large copper shank of cross-section 40 to 50 times that of the focal spot area. In designs such that the focal spot area is larger in comparison with the area of copper backing the allowable energy intensity is less. For example, with a copper backing only 10 times as large as the focal spot the allowable energy input for one second is decreased to approximately 125 watts per square millimeter.

The extreme temperature changes and differences accompanying bombardment of the intensity just mentioned produce severe mechanical stresses in the tungsten. In order to minimize cracking due to these stresses the quality of the tungsten has to be carefully controlled during its manufacture (16). The severity of the stresses also increases with the size of the focal spot, so that with large focal spots of the order of

100 square millimeters or more it is almost impossible to prevent some cracking during a reasonable life. A very fine grain or fibrous structure minimizes the cracking and prevents small cracks from spreading over a large area. This is helpful because cracks are only harmful if they distort the face of the focal spot, reduce the heat conduction, or allow copper to come through the tungsten button to the focal spot (Fig 6).

**Focal Spot Shape**—For radiographic purposes the focal spot size, shape, and angular position with respect to the film are of first importance. Along with other influences (most important of which is the part to be radiographed its size, thickness, distance from the film, and motion) the focal spot determines such radiographic factors as film detail, tube-part distance, speed, power required, maximum allowable film size, and change in detail over the film. Table II should give a rough qualitative

idea as to how these factors are influenced by focal spot design, although interpretation of this table should be done cautiously inasmuch as its conclusions are simplified by ignoring many practical considerations.

From the table it will be noted that increase in detail without sacrifice in speed, or *vice versa*, can be obtained by changing the angle of the target face (the focal spot shape being kept such that its projection on the film is a circle or square), but not by decreasing or increasing focal spot size. On the other hand, it also will be noted that as the angular position of the focal spot is made more nearly vertical with respect to the film, the size of film that can be covered at a given tube-part distance, and with a certain allowable change in detail over the film, is rapidly diminished. In order to increase detail without changing speed or *vice versa*, and still cover as large a film as previously possible, a smaller angle target, increased tube-part distance, and considerably increased power are necessary. Exception may occur when there is motion of the object being radiographed. In this case, increase in speed may decrease (or at least not increase) blurring on the film even though the speed theoretically is obtained at the expense of detail, that is, by increased focal spot size without change in the angle of the target or tube-part distance. In many cases in the past it has been possible to cover with a  $45^\circ$  target and without noticeable distortion in detail over the film, a larger film than needed. In these cases the proper  $20^\circ$  anode gives better detail or speed without increase in power.

For a number of years a rotating anode target (5) theoretically has offered possibilities of allowing increased radiographic detail without sacrifice in speed. Fundamentally it involves rotation of a small focal spot with respect to the anode (and therefore distribution of the energy over a large area on the anode) without motion of the

focal spot as far as the part to be radiographed and film are concerned. To date, mechanical complications of rotating the anode in a vacuum and conducting heat from it or of rotating the entire tube have limited and made expensive construction of a tube of this type.

No one tube or focal spot design can meet all of the situations and requirements encountered in radiographing various portions of the human body, not to mention other objects ranging from delicate flowers to  $\frac{1}{4}$ -inch thick boiler steel. Focal spots of a number of different sizes and designs are in general use and must continue to be in use. It is outside of the scope of this paper to discuss the many complicated, and in some cases controversial, considerations that lead to a particular selection. A number of books and papers have been written on this subject (1, 2, 10, 12). As far as tube design is concerned it is sufficient to show the influences of focal spot design on radiographic factors, the resulting need for different designs, and finally, how to get them.

*Cathode Design*—The problem of designing a cathode structure to give a desired focal spot size and shape is primarily a problem in electrostatics. Electrons given off by the hot cathode filament are started in the general direction of the anode by that portion of the electrostatic field (and magnetic field) immediately surrounding the filament. From then on, throughout their travel, they are accelerated in the direction of the field in which they are momentarily located. In general this field is quite complicated because of the unsymmetrical electrode shapes, the influence of charges on the envelope and space charge. As they approach the anode, their path is influenced less by the field because the velocity and momentum they have acquired resist changes in direction of motion. For this reason the field surrounding the anode does not have as much influence in determining the focal spot as that around

the cathode. The focal spot size, shape, and distribution can be controlled almost entirely by the filament size, shape, and position relative to the rest of the cathode structure (Fig 7)

The necessity for fairly uniform distribu-

favorable conditions of heating and electron bombardment

*Sources of gas* that must be eliminated during manufacture, in addition to merely pumping out the gas occupying space in the tube, are

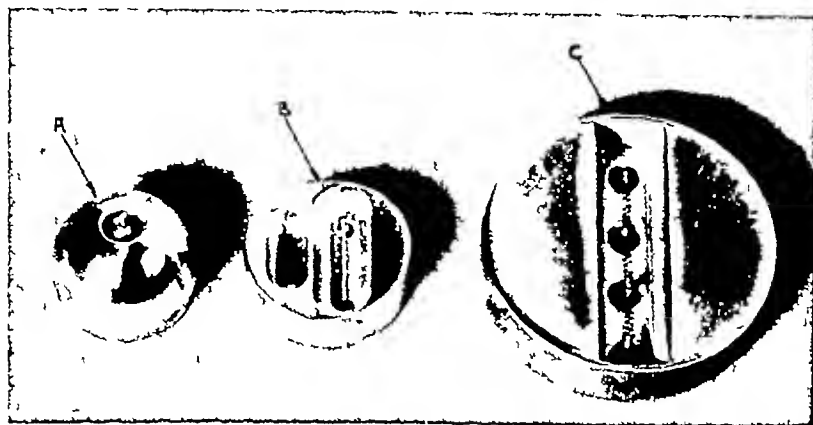


Fig 7 Illustrations of cathode design (A) Round focus therapy cathode (B) Double elongated focus diagnostic tube cathode (C) High power, 1000 ma. tube cathode

tion of energy over the focal spot makes the cathode design more difficult than otherwise would be the case. Usually the filament is mounted in a slot or opening in the cathode, and best distribution is obtained with a focal spot of about the same dimensions as this opening. It is possible to obtain, however, a focal spot either smaller or larger than the slot in which the filament is mounted by varying the depth of the filament in its slot by varying the shape and size of the cathode around the slot (the so-called focussing cup), or by insulating the filament from the surrounding cathode and giving them different potentials (13)

## PART II MANUFACTURE

### 1 Assembly and Exhaust

X-ray tube manufacture centers around the degassing and exhaust of the tube and its various parts. In no other vacuum device are the requirements so severe as to degree of vacuum and its maintenance under un-

1 Liquids and solids, especially organic, of low melting point or unstable composition. This includes water, mercury, and all oils and greases. These substances either have a relatively high vapor pressure or are potential sources of gas at the temperatures which may be reached.

2 Absorbed gas. All solid materials normally contain more or less absorbed gas which may be liberated, to some extent at least, on heating of the material.

3 Adsorbed gas, that is, surface films of gas. All solid materials also normally attract a very thin film of so-called "adsorbed gas" on their surface which can be eliminated in a vacuum by high temperature.

Processes for eliminating these sources of gas depend for their effectiveness upon heat applied either in a vacuum or reducing atmosphere of hydrogen, and upon extreme cleanliness. Heat processes in common use are vacuum melting, hydrogen firing, high frequency vacuum firing, vacuum bake out of

glass at from 400 to 500 degrees centigrade, and, in the assembled tube on exhaust, operation as an x-ray tube with consequent heating of the cathode, anode, and various portions of the glass. Additional precautions in cleanliness involve the use of distilled wa-

ter (Fig 8). Many of the newer tubes are being designed with high frequency heating in mind and would be difficult to exhaust without it.

For many years exhaust was more or less an art because of the lack of any satisfac-

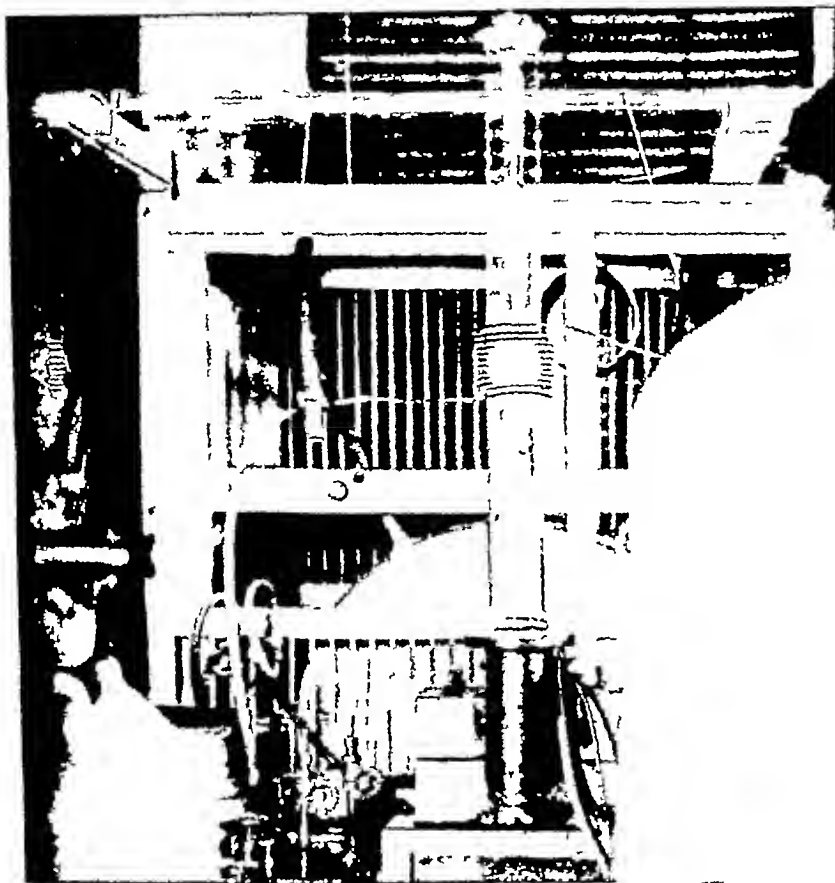


Fig 8 Process of heating by high frequency current a therapy tube anode

ter and distilled alcohol white gloves for handling parts, hot boxes for temporarily storing parts and nitrogen and liquid air for preventing oxidation during glass-blowing work.

High frequency heating is used during exhaust to degas parts of the tube that adequately could be heated in no other manner. In this method of heating energy at radio frequency (wave length from 100 to 1 000 meters) is transferred by induction or radiation from a coil around the outside of the tube to the metal electrodes inside the

tory simple measuring device for the order of pressures involved, and more important yet any measuring device for the degree of degassing. With a fast pumping system a tube might be exhausted to a very low pressure but be very poorly degassed, that is, if it were removed from the pump its pressure would gradually rise to a prohibitive value. Two tools, the ionization gauge and mercury shut-off have done much to make exhaust a more exactly measurable process (Fig 9).

The ionization gauge (8, 15) is a sensitive instrument for the measurement of gas

pressures of the order of magnitude necessary in an x-ray tube, and is simple and practical enough to be used on every production exhaust system. It has made possible the important advance of exhaust

system, heat all its parts hotter than they should become in actual operation, note the resulting increase in gas pressure, and then be able to continue the exhaust process if the test is not satisfactory

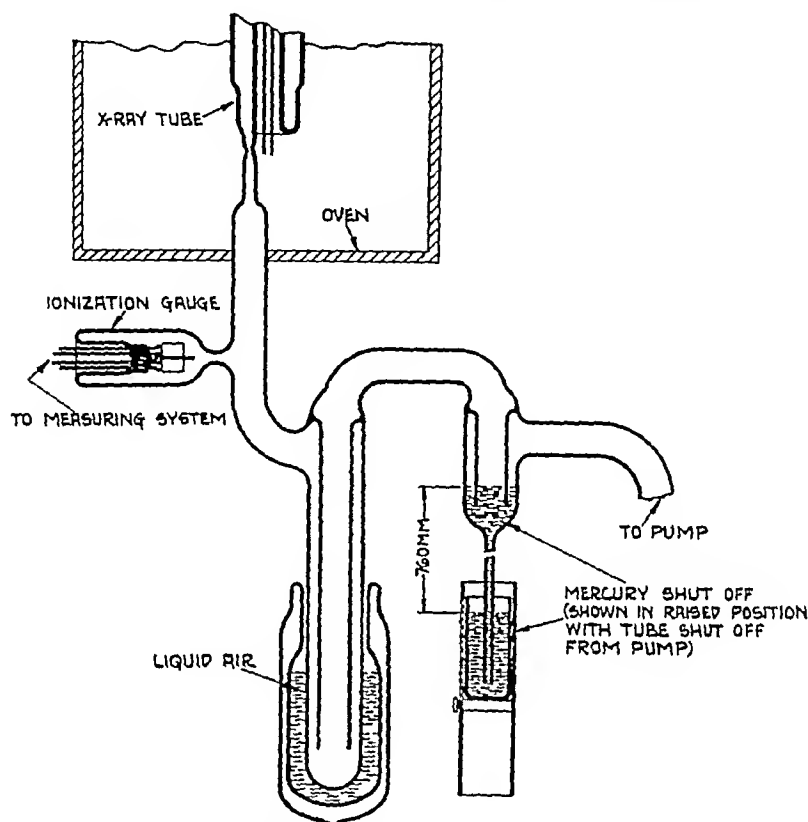


Fig 9 Schematic diagram of an exhaust system showing ionization gauge, liquid air trap, and mercury shut off

schedules based on pressures instead of upon appearance and time

The mercury shut-off is a simple arrangement in the exhaust system allowing the x-ray tube to be quickly and temporarily shut off from the pump. In connection with the ionization gauge it makes possible the testing of a tube for completeness of degassing before the tube is disconnected permanently from the pump and while there is still a pressure indicating instrument on the tube. The importance of this cannot be too greatly emphasized, that is, of being able to temporarily disconnect a tube from its exhaust

There have been other improvements in exhaust technic (7). Pumping systems are in general much faster than they were a few years ago. Liquid air is used as a cooling medium to insure complete condensation of water and mercury vapor. Hard glass can be baked out at a higher temperature than the earlier soft glasses (500° centigrade as compared to 400°) and consequently can be more thoroughly degassed.

## 2 Production Tests

No processes of manufacture are more important than the final ones of inspection and test. The last production tests are those

in which the tube is operated at higher energy and higher voltage than its rating. These overload tests insure a factor of safety that is essential to good tube operation under the varying conditions that may be met and to take care of errors in measurement of K V P, ma, and time. In addition, they give an opportunity of discovering defects in a short time that might not be apparent for a long time at normal operation. The following outline gives a general idea of the routine production tests that have been found desirable for diagnostic tubes.

1 Gas tests while the tube is still on exhaust. The importance of being able to test the thoroughness of degassing before the tube is taken off exhaust permanently has already been discussed.

2 Inspection for mechanical defects.

3 Filament volt-ampere test—insures that the filament will operate within specified limits of voltage and current.

4 Focal spot pictures on every tube—insures that the focal spot size is within specified limits and that the energy distribution is good.

5 Anode overload test at 120 per cent or more of rated energy insures a safety factor in the rated energy.

6 Cathode overload test—filament operated above maximum rating for a long period of time (30 minutes)—insures a thoroughly degassed cathode structure.

7 Focal spot load test insures proper operation of the tube at high energy short time exposures.

8 Over-voltage test at 120 per cent rated voltage insures a safety factor in rated voltage.

9 Milliamperage drop test given a minimum of 24 hours after the preceding test insures against leaks and the presence of certain gases that poison tungsten electron emission and cause an appreciable change in milliamperage during a long exposure.

10 Second inspection for mechanical defects.

11 Test immediately before shipment of tube. In general a tube should be kept in stock for at least two weeks. This insures against very slow leaks that may not have shown up on the first leak test.

12 Final inspection.

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# NEW METHODS FOR THE DETERMINATION OF HIGH POTENTIALS AND HIGH POTENTIAL WAVE FORMS

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AS has been remarked more than once, the advancement of the science of medical radiology requires a general realization of the importance of precise and quantitative measurement. It equally requires, be it also remarked, the further development of means for the performance of these precise measurements. Some of the measurables concerned have been particularly refractory. Many schemes have been proposed for the measurement of high potentials, yet this important operation is still far from standardized, either in the laboratory of the roentgenologist or in other scientific or technologic fields.

The present paper contributes a description of an instrument, thought to be novel in principle, which was originated for the measurement of high voltages in the physical laboratory. The interest shown in the device by roentgenologists prompts this presentation of some applications to the medical field. While the instrument to be described is not at present commercially available, it is relatively simple in construction, and it is probable that experimenters will be able to adapt its principles to their own purposes.

The central feature to be introduced here is the instrument pictured in Figures 1 and 2 and referred to hereafter as the rotary voltmeter. In elucidating the operation of this device the diagrammatic representation of Figure 3 will perhaps be more serviceable than the photographs. In this diagram  $A$  and  $A'$  designate two insulated conductors, electrically connected to the respective terminals of the source of high potential to be investigated. For the present, suppose this potential to be direct and constant so that a steady potential difference,  $V$ , exists between  $A$  and  $A'$ . Between these two terminals is mounted a metal cylinder, which

appears in cross-section in the figure. The cylinder is split longitudinally, the halves being held rigidly together by insulating material and electrically joined only through the conductor  $R$ . Means are provided for causing uniform rotation of the cylinder about its own axis, as shown by the arrow.

It is evident that as the cylinder turns bringing its upper half nearer to the positively charged terminal, a negative charge will be drawn to this semi-cylinder, the opposite one becoming positive, and the combined process resulting in the flow of an electric current through  $R$ . The charges on the semi-cylinders attain their maxima when the plane along which the cylinder is divided is vertical, and if the rotation continues past this position the semi-cylinders will begin to discharge and then to build up charges of reversed sign. Continuous rotation thus produces an alternating current in  $R$ , a current whose average absolute value  $I$ , is related in a very direct manner to the potential difference  $V$ .

To render this induced current measurable and simultaneously to rectify it, the simple commutator and brush system of Figure 4 is added. This figure also includes the direct current galvanometer or microammeter necessary for the current measurement. Simple theoretical considerations and numerous experiments have shown the relation  $V = I/2 Cn$  to subsist between the applied voltage, the generated current, the number of revolutions per second  $n$ , and a capacitance  $C$  characteristic of the high potential terminals and the cylinder. The electrical quantities are in practical units. The capacitance  $C$  is constant and measurable, and the constancy of  $n$  is insured by the use of a synchronous driving motor. The measurement of the applied high po-



tential thus becomes merely a matter of measuring a small direct current in a circuit which is at or near to ground potential, the relation between the voltage and current being conveniently linear

The essential parts described above may be identified in Figures 1 and 2, in their shielding metallic box. This model was built for use with potentials up to 110 kilovolts. Extension of this range upward would require only increasing the clearances between the high potential terminals and the cylinder, so as to preclude sparking at these gaps.

The equation which describes the performance of voltmeters of this type and which was given above has been found applicable over the extremely wide range of voltages covered by the graph of Figure 5. The logarithms of applied voltages and generated currents have been plotted here, rather than the quantities themselves, because of the wide distribution of the data. Either method would serve to display the linear relationship existing between these quantities, and direct measurements of the voltmeter capacitances confirm the working equation  $V = I/2 C n$  in detail. Such confirmation is of some practical importance since it permits us to establish the calibration of these instruments in what may be called a semi-absolute manner, that is by simple measurements which do not involve comparison with spark gaps, spectrum measurements or any other system for measuring high potentials.

In using the voltmeter pictured in the first two figures in the physical laboratory we have ordinarily preferred to measure the generated currents with a d'Arsonval galvanometer but a switchboard microammeter of the pointer type may be used equally well and would often be found more convenient particularly if calibrated to read kilovolts directly and perhaps furnished with shunts to cover different voltage ranges.

If the potentials to be measured are not constant but periodically variable as are the

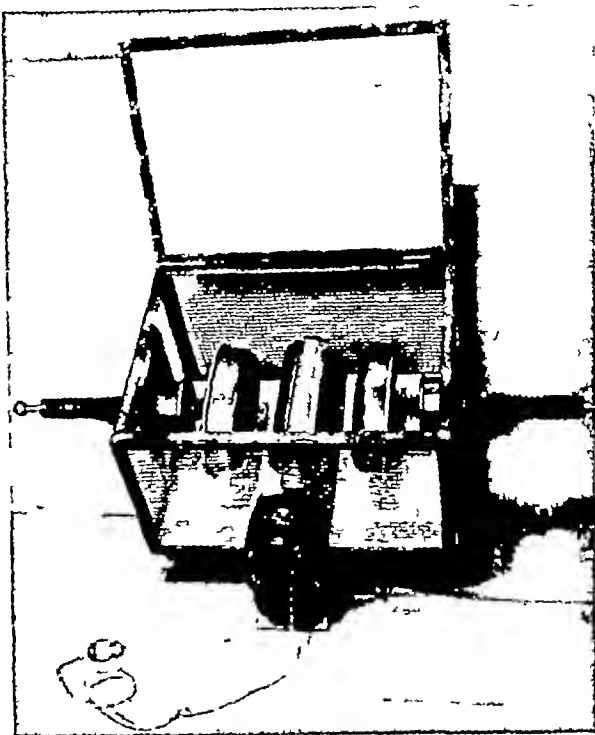


Fig 1 Rotary voltmeter for high potential measurement. Complete except for galvanometer

potentials delivered by the ordinary synchronous rectifier and by tube-rectified power plants when condensers are not present, the current generated by the rotary voltmeter depends upon the phase relationships subsisting between the revolution of the rotor and the variations of the applied potential. More specifically the generated current is proportional to that particular and recurrent value of the applied voltage which obtains at the instant when the semi-cylinders of the rotor are most closely presented to the high potential terminals. If provision be made for varying this phase relationship, the whole voltage wave may be plotted out in a point-to-point manner.

This may be done in a variety of ways. In obtaining the wave forms accompanying this paper, it was done by using a phase-shifting transformer to furnish the current required for operating the synchronous motor. This method is quite convenient and allows all operations to be carried out at a

location remote from the high voltage if desired. The phase-shifting transformer, a device familiar to electrical engineers, furnishes secondary current which may be adjusted at will to make any desired phase

by this method. They are of little interest in themselves but suggest a number of applications for apparatus of this kind. These curves present voltage wave forms, taken at the x-ray tube, for a variety of different

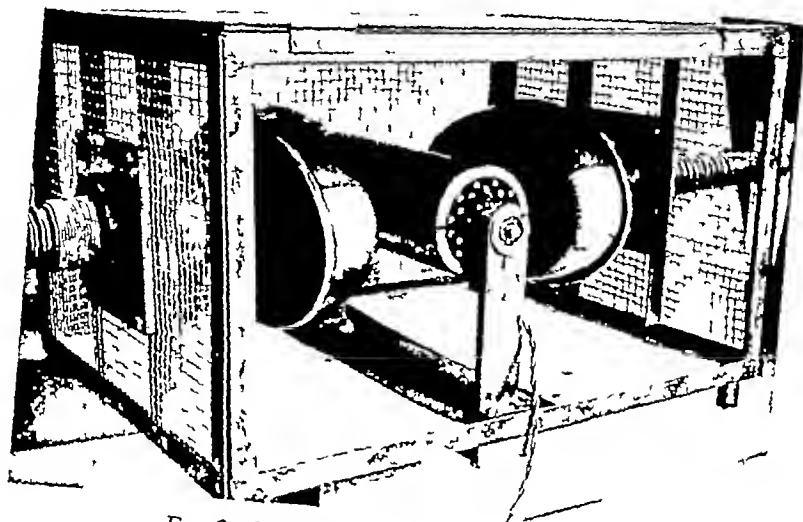


Fig 2 Detailed view of rotor and poles

angle with the voltage applied to its primary. Any adjustment of this transformer, therefore, advances or retards the synchronous motor correspondingly. In determining a wave form, points may be plotted as closely

load and line conditions. Abscissas represent time, the units being electrical degrees of the alternating current supplied to the primary of the high potential transformer, of which 360 occupy one-sixtieth of a sec-

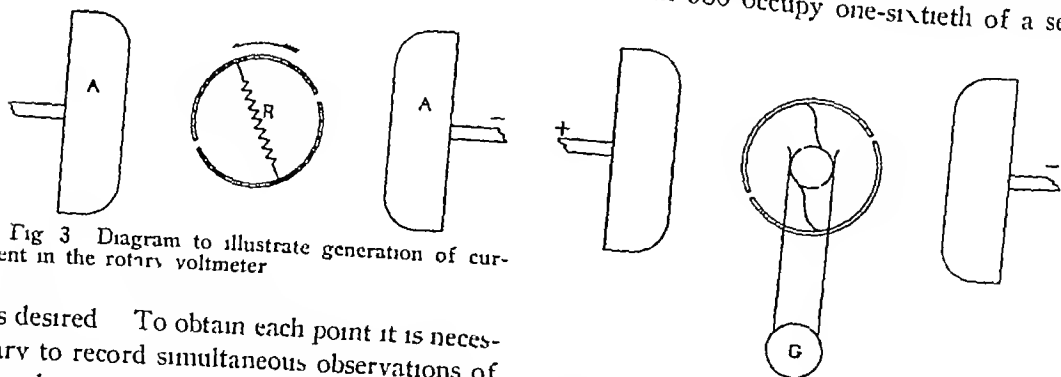


Fig 3 Diagram to illustrate generation of current in the rotary voltmeter

Fig 4 Diagram of the essentials of the rotary voltmeter

as desired. To obtain each point it is necessary to record simultaneous observations of the phase-angle scale of the transformer and the galvanometer or microammeter which measures the generated current. Points may be plotted at a rate of half a dozen or more per minute.

The wave forms of Figures 6 to 10 are presented as samples of what may be done

and. The relative phases of the curves are arbitrary and without significance. Figure 6 shows the potential difference across a Coolidge x-ray tube which was connected directly to the high tension terminals of the

transformer, and carried an average current of three milliamperes. The active half cycle is represented in the figure by the upper half wave. It is noticeable that the inverse peak

potential is distinctly higher than that of the active half cycle and that the form of the active half shows the distortion from a sinusoidal form which results from the

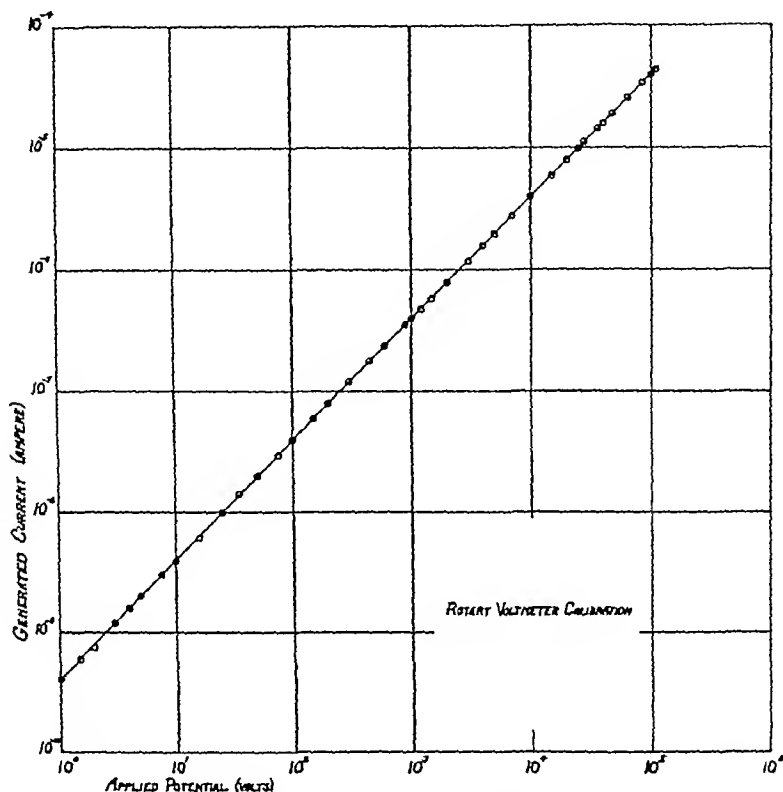


Fig 5 Rotary voltmeter calibration curve

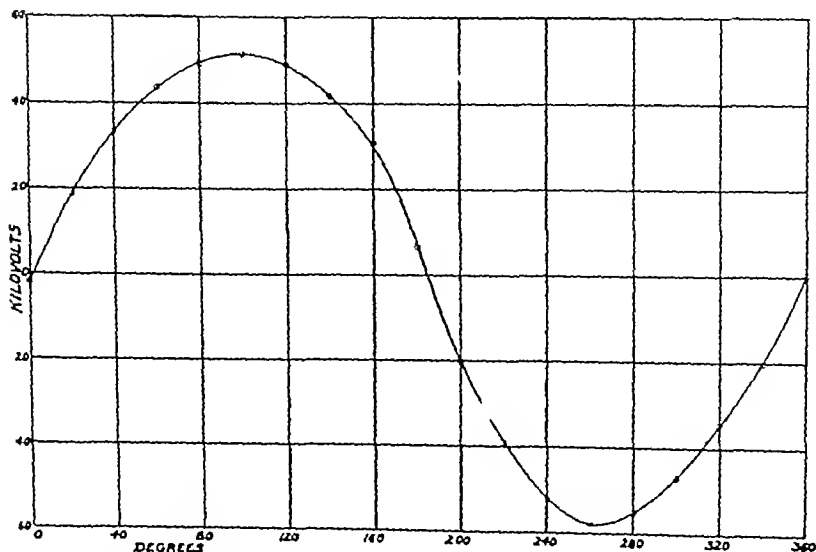


Fig 6 Wave form of the potential difference across a Coolidge tube connected directly to the secondary terminals of a high tension transformer

varying potential drop across the resistances of the line and the transformer

In Figure 7 kenotrons have been inserted

cline to zero during the idle half cycle is evidence of an appreciable capacitance in the line and voltmeters The potential rises to

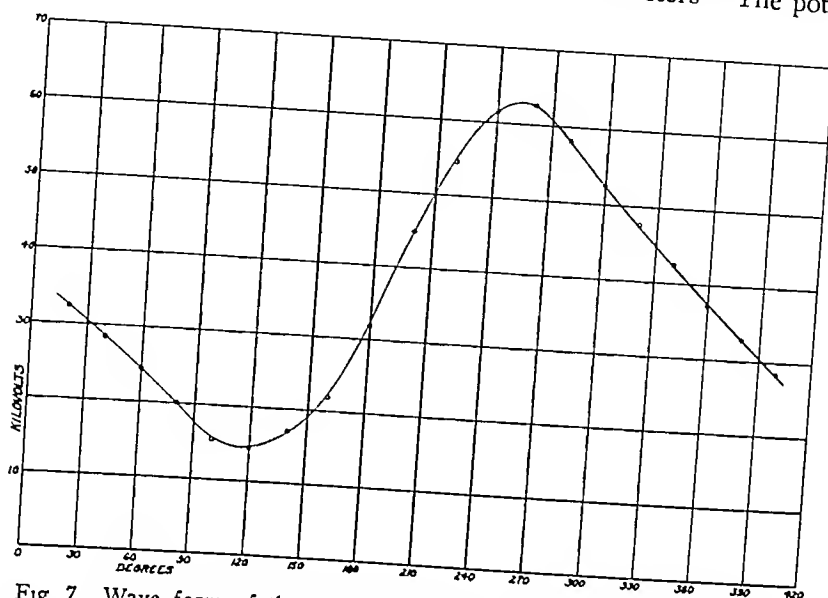


Fig 7 Wave form of the potential difference across a Coolidge tube connected in series between two kenotrons

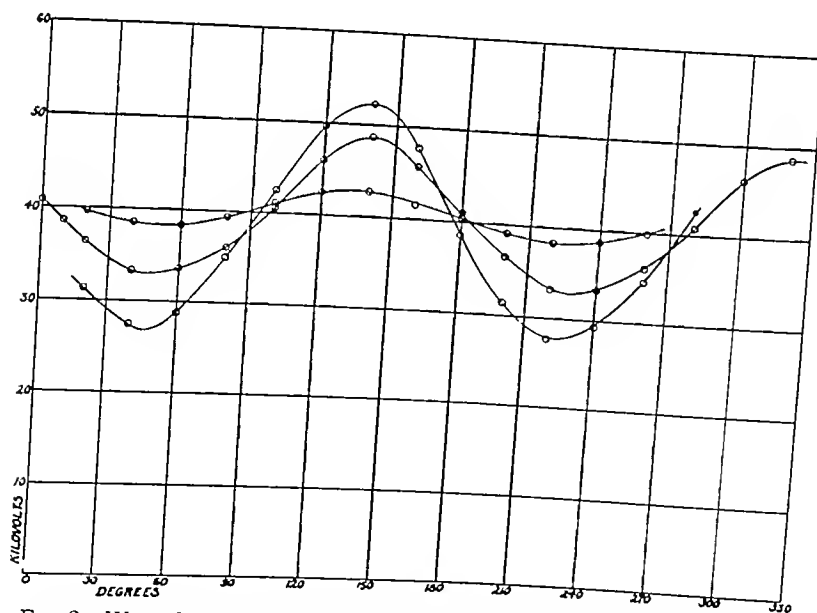


Fig 8 Wave forms of the potential difference across a Coolidge tube supplied by a four kenotron set producing full-wave rectification

on each side of the tube, so that the potential across the latter can not have negative values The fact that it does not even de-

its maximum along a smooth and approximately sinusoidal curve and then declines along a straight line is the condensed

charges escape through the tube. The slope of this line indicates a capacitance of 0.00074 microfarad.

The effect of load current upon ripple is clearly demonstrated.

The curves of Figure 9 differ from those

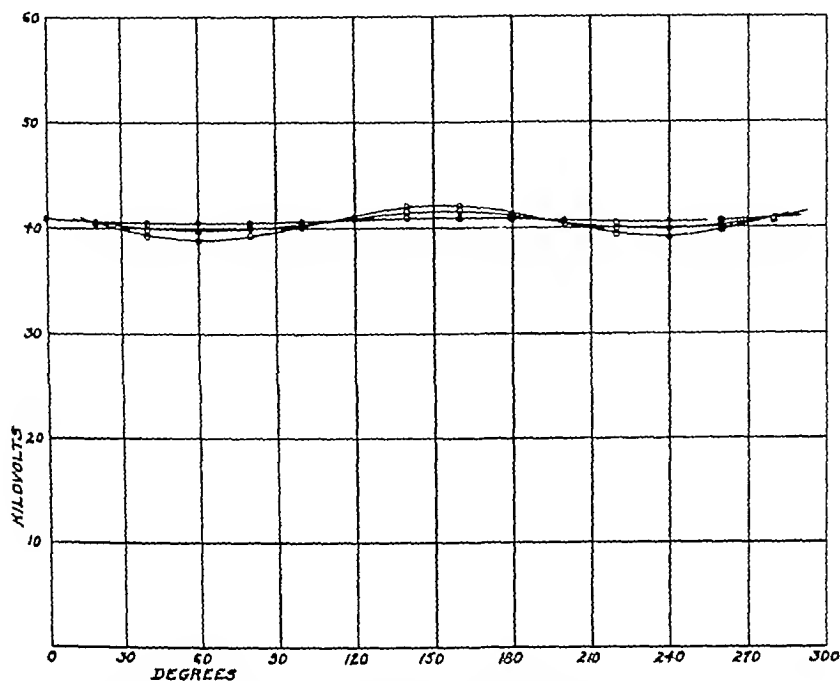


Fig 9 Wave forms obtained under conditions like those of Figure 8 except for the addition of capacitance in parallel with the tube

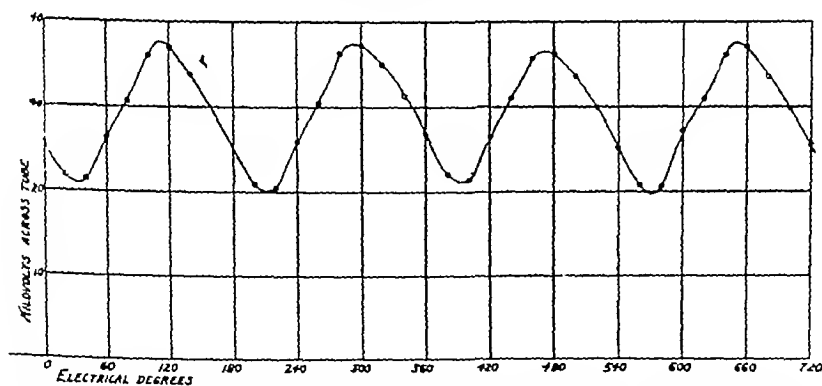


Fig 10 Wave form of the potential difference across a Coolidge tube supplied with synchronous-rectified potential

Figure 8 was obtained by the use of four kenotrons so connected as to effect full wave rectification. Again the line capacitance was sufficient to smooth the voltage variations quite appreciably. The three curves of this figure are for three different values of tube current, 112, one four and eight

of the preceding figure only in that several large plate glass condensers were connected across the tube, very much augmenting the smoothing action of the line and instrument capacitances. The one-milliamper curve of Figure 9 has a ripple of only 2 per cent and approximates to constant potential. The

abruptly peaked curve of Figure 10 was secured while the tube was being operated from a synchronous rectified set without smoothing condensers

A summary of the chief characteristics of the rotary voltmeter is presented here in conclusion. This is a strictly portable instrument, which is not deranged by handling and which requires no levelling or other adjustment when set up for operation. The range extends from a fraction of one volt to the highest obtainable potentials. The meter is accurate to a small fraction of one per cent. The indicating unit of the instrument ordinarily has a linear scale and a short period. It is kept at ground potential and may be located at any distance from the high voltage circuits. The range of the meter may be instantly changed by shunting the indicating galvanometer or microam-

meter. The calibration is readily established by simple low voltage operations, and this calibration remains constant. Errors due to temperature variations are negligible. The meter draws no current from the high voltage source. It is equally suitable for the measurement of constant and of periodic potentials, and in the latter case an auxiliary transformer converts the voltmeter into an instrument for plotting high potential wave forms.

The reader who wishes to consider the rotary voltmeter further is referred to two papers (1) on this subject, where many points touched upon above are more fully elaborated.

#### REFERENCES

- (1) KIRKPATRICK PAUL and MIYAKE IWAO Rev  
Sci Inst 1932 III 1  
KIRKPATRICK PAUL Ibid p 430

## TREATMENT BY RADIATION OF CANCERS OF SKIN LIP AND BREAST<sup>1</sup>

END-RESULTS THREE YEARS LATER OF CASES PRESENTED IN 1929

By BARBARA HUNT M.D. BANGOR, MAINE

**M**Y intention is to carry on the report<sup>2</sup> given at the Toronto meeting, in 1929, bringing it up to date so far as the number of deaths is concerned. The interest in this small group of cases seems to lie in the experiences gained in an intimate relationship between radiologist and patient during a period of ten years.

#### CANCER OF THE SKIN

In my previous paper I reported 279 cases treated between 1922 and 1929, with 24 deaths from cancer and 197 cases free of the apparent disease. Of the latter three have since succumbed to recurrences.

The simplicity of our treatment seems pleasing to the patient involving as it does no pain or discomfort only a few hours' stay in the office chair and six weeks of moderate scabbing to which no treatment or dressings are applied. The patient is advised to leave the treated area severely alone, exposed to the air, and to keep it as dry as possible. Occasionally at the first inspection after the final scab has dropped off, a second smaller treatment is required for some heaped-up spot on the edge which failed to receive sufficient radiation through slipping of the protective shield or too small a window. Rarely it is evident at the end of six weeks, by some induration or appearance varying from the usual, that the original dose was not heavy enough. In such a case,

<sup>1</sup>Read before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City Nov 28-Dec 1 1932

<sup>2</sup>Report on the Use of Radium and Deep Therapy X-ray for the Last Seven Years in a Private Clinic in Maine, with Special Reference to the Problems of the Small Community. Barbara Hunt. Radiology November 1930 XV 585-589

a second application of a lesser intensity is made

This method has been successful in locations all over the face, scalp, neck, dorsum of hand, dorsum of trunk, extensive eroding and bulky growths on rim or shell of ear, tumors containing black pigment or rising from pigmented background, at the inner canthus of the eye and involving the ala of the nose. Needles are sometimes buried in a bulky growth, and, in extensive cancers, treatments are given on successive days until the ground is thoroughly covered. However, such cases constitute a minority of those seen and are becoming fewer in number, due, I believe, to the increased ability of the medical profession to recognize cancer at earlier stages, and to the willingness of the public to accept painless methods of treatment by irradiation.

The three deaths noted were all in ear cases. One had a history of cancer in this location since 1912, one was unfavorable constitutionally, being arteriosclerotic and anemic, and the other had infection and extension into the parotid gland. Infection of the tissues of the head adjacent to the ear is a dangerous complication, and removal of the scab and disinfection of the ulcer with Bohlman's gentian violet solution, together with hot compresses, has, I think, saved one patient.

Recently, recurrence in radiation fibroses in individuals with strong cancerous tendencies (as indicated by multiple skin cancers) has been resected surgically, with immediate rapidly growing recurrence in the edges of the incision. In these cases it is my experience that promptness in the treatment of these recurrences in the edges of the incision is a necessity. In fact, radiation on the day after the operation is likely to catch the activated cells at the most propitious time.

From the standpoint of the patient, I cannot yet see the value of biopsy in cancer of

the skin and feel that only rarely is it necessary or justified. Other common diseases do not present the appearance of a translucent, waxy, discrete nodule, or the heaped-up, indurated edge with eroding center, or the dry, slightly scabbing crack with underlying induration. When the cancer is of an infiltrating character, biopsy is dangerous and mutilating, when cancerous tissue is redundant, the diagnosis is obvious. Moreover, it is undesirable to inject a local anesthetic with a view to taking a biopsy specimen and it is not safe to cut into a melanotic tumor. If you must have a biopsy for your diagnosis, wait until after you have treated the lesion with radium since then the biopsy may be harmless. If prominent pathologists find both basal and squamous cells in the same tumor and if squamous-celled tumors sometimes occur in regions popularly allocated to the basal-cell type, common sense and experience teach us to use a sufficient dose in all skin cancers to kill the squamous cells if they are present. As a matter of fact, the decision of the proper dose to use comes within the scope of the art of our profession to a considerable extent and is something that we learn in our apprenticeship. It depends somewhat on the depth of induration, somewhat on the size, and somewhat on the pigmentation, as well as upon the known physical and biologic factors. Another point to be considered is the coloring of the skin of the individual, a very dark skinned person requiring heavier dosage.

#### CANCER OF THE LIP

This is another field in which radium is highly successful. In 1929 I reported 145 cases of cancer of the lip, with 21 deaths and 99 cases apparently free from the disease. Since then, three have died from recurrences, making 24 known deaths in the years 1922 to 1929. Let us lay aside such deaths as are attributable to other grounds than the method of treatment.

The small uncomplicated cancer of the lip can be treated in a simple way and during a few hours' stay in the office. It is not necessary to put needles through the lip, to curette the growth, to electrocoagulate, to hospitalize the patient, or to do anything more than lay radium over the top of the nodule or on the two sides in order to employ cross-firing. A shield can be made for the rest of the lip out of lead covered with rubber dam attached with patching cement, with a window to uncover the cancerous nodule. A prophylactic treatment over the submaxillary and submental areas consists of erythema bandage packs which may be left on over night while the patient sleeps. Treatment of such cases as are uncomplicated by palpable glands proceeds as uneventfully and surely as that of cases of cancer of the skin. The dosage is a little larger and the excoriation of the lip a little disagreeable, but with the aid of a vaselined cloth between the lips at night to prevent adherence in the morning, the patients are able to continue about their occupations and the lip heals in from six to eight weeks. When there is suspected metastasis in the cervical glands, I employ deep therapy x-ray plus radium packs to skin toleration and find it reasonably successful. Cancers of the lip which have spread beyond the vermilion surface, if not accessible to cross-firing, I treat with buried radiation in addition to external form. I am still using steel-jacketed needles in this work.

In the hopeless cases, with bulky and many metastatic glands and extensive proliferative and eroding sores on the lip, to delay and palliate the growth by burying radium and using deep therapy x-ray is decidedly worthwhile when the final result is compared with the distressing terminations in cases in which the cancer is allowed to proceed uncontrolled. I would urge that we show courage in recommending the use of radiation for its palliative effect upon such

cases. The extremely neglected cases are frequently town or state paupers and there is a tendency for the local consultant to consider treatment unnecessary on account of the hopelessness of the case. Let us not lose sight of the fact that radiation furnishes a means of rendering death from cancer less distressing.

Tobacco or foul teeth still play their part and can be depended upon to produce recurrences unless prohibited.

#### CANCER OF THE UTERINE CERVIX

From 1922 to 1929, 104 cases were treated, the cases appearing free from the disease being 26. During the last three years, five of those 26 cases appearing free from the disease in 1929 have died from cancer. Since then there have been 22 more cases making 126 in all, and of these there are eight known deaths and seven cases apparently free from disease, making for the ten years 126 cases and 28 apparently free from disease.

In general, these results are far from satisfactory. Many cases improve and the cancer disappears entirely from the vagina and uterus, but four months, six months, a year or two years later the pelvic floor and rectal wall become infiltrated and death ensues. It seems to me that treatments should be repeated by means of the deep therapy x-ray at intervals during the first year or two. It is too much to expect to cause the death of all the cancer cells at one blow. I find that by using a course of deep therapy x-ray treatments before applying radium, the tumor can be cleaned up and the proliferating growths so shrunk that it is easier to find the uterine canal and I do not have the rises of temperature, the chills, and signs of toxemia which sometimes follow radium insertion.

My method of treatment uses less filtration than is used in common practice. The steel needles or silver capsules are placed



tandem-fashion in a piece of wax catheter cut to the measure of the uterine canal and covered with thin rubber tubing. This applicator is somewhat flexible, small enough to be inserted without much trauma, and the results seem to justify continuation of its use. The caustic effect is not marked and the local cancer disappears with healing except in the cases of badly infected eroding ulcer. I do not know of any treatment which is more than palliative in this latter condition.

#### CANCER OF THE BREAST

I have not found deep x-ray therapy successful in causing permanent arrest of cancer of the breast. Of the six potentially operable cases treated by radiation alone which were reported in 1929, two have died from cancer, two more are now undergoing treatment for re-appearance of the disease in the breast, one has just had a radical surgical removal of the breast, and a patient who was treated in 1924 by insertion of radium needles plus fractional deep therapy radiation is the only case left with the disease quiescent. The disease apparently disappeared for long periods of time but recurred in such a state of fibrosis that further treatment only broke down tissue without causing recession of the cancer. However, the immediate effects of radiation of some tumors of the breast are certainly brilliant, and I am sure there is a future for this kind of treatment when we understand better how to apply it.

During the course of radiation on an advanced epithelioma of the breast in which the breast tissue had been reduced to a nodule the size of a thumb and disease was spreading over the skin of the chest as an inflammatory thickening, with a sharply demarcated slowly advancing margin. I was given opportunity of observing the effects of radium on a tissue culture of cancer cells taken from the mammary cancer of a mouse. To my surprise I found that a compara-

tively large amount of radiation at short range had no effect upon the cells of the tissue culture for several days, whereas 24 hours after deep therapy radiation of the human breast cancer, there was pronounced shrinking and pallor of the nodule and indurated skin. This would seem to indicate that the action of radiation was not upon cancer cells themselves but upon their bed.

#### HYPERTHYROIDISM

Out of a total of 34 cases prior to 1929, there have been five operated upon after radium treatment, three who reported themselves unimproved, and 16 with symptoms of rapid pulse, exophthalmos, tremor, and the symptomatic "internal trembling," whose symptoms have been greatly improved and the basal metabolism rate lowered.

Radium is a valuable therapeutic agent in hyperthyroidism. The relief afforded by its application on the glands is remarkable. The heart slows its beat, anxiety diminishes, and tremor is relieved. The tumor usually shrinks and sometimes is greatly reduced in size. Exophthalmos often lessens in degree. Sometimes this effect is produced by a single application of gamma rays on the gland, but more often repeated treatments are necessary. That the therapy is not subjective is shown by the striking decrease in metabolic rate. In the first years of my use of radium, several such cases were restored to health and their daily occupations. A number of cases of lesser degree were benefited. Since the popularizing of the surgical treatment in the hands of specialists, I do not see many cases. If we were to specialize in this line of treatment as do the surgeons, we would be able to hold our patients and produce results which would compare favorably with those of surgery.

#### CANCER THERAPY IN THE STATE OF MAINE

Radiologists see more patients with cancer and are more interested in solving the problem of cancer than any other group in

the medical profession, in our preoccupation with our new agents of therapy, we are neglecting our responsibility in not taking the lead in the war against cancer. The American College of Surgeons has suggested the formation of special groups in hospitals to study the cancer patients and plan their treatment, but in our State there is only one hospital in which such a group has been formed, the chief reason being that the surgical staffs do not recognize the advantages which would come from an intensified study of each case and the application of modern methods of treatment. Cancer is only one of many fields in which a surgeon is interested, but it is the most important one to a radiologist.

In the State of Maine no radium is owned by any hospital and only one hospital has a deep therapy installation, due to the prevailing idea of the surgeons and roentgenologists that the diagnostic x-ray machine of medium voltage is suitable to treat cancer. The surgeons with whom I am acquainted recognize the post-operative treatment of cancer of the breast, the treatment of recur-

rences, the treatment of abdominal fibroids, and post-operative malignancies of the ovary by the medium voltage x-ray. Cancer of the cervix when inoperable is referred to the radiologist if there is one available, other inoperable cancers are diagnosed as hopeless and the patient sent home without treatment, without reference to the radiologist, and with no knowledge on the part of the surgeon of what might be done by x-ray or radium.

The cancer committee of the State Medical Society was formerly composed of two pathologists and a radiologist. This committee was interested in cancer, arranged a survey of the State by the American Society for the Control of Cancer, and promoted education of the public. However, it was soon recognized that facilities for treatment were lacking. This year, three surgeons were added to the committee but no progress has been made so far. Radiologists as a class are retiring, modest and immersed in the problems of their specialty, but I believe they should take the initiative in the organization of the medical profession for the control of cancer.

## THE ROENTGEN DIAGNOSIS OF MASSIVE ATELECTASIS OF THE LUNG

By J. B. JOHNSON, M.D. GALVESTON, TEXAS and  
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**M**ASSIVE atelectasis has been known for a long time, but it is the work of Pasteur, published in 1910, that has been the stimulus and the basis for the more recent investigations in this field. Such able essayists as Bowen, Lee, Tucker and his associates, and Coryllos and Birnbaum have presented experimental evidence which does much to reveal the process of events which leads up to this interesting condition.

However, in spite of much recent interest in massive atelectasis, there are, unquestionably, many cases which are incorrectly considered as pneumonia.

The term is applied to a condition of collapse of one or more lobes of the lung. The cause of this collapse is generally accepted to be the complete occlusion of a bronchus, by an aspirated foreign body within a bronchus, or, as is far more common, a mucous plug. The symptomatology will vary within wide limits from the "catastrophic" of Luc

<sup>1</sup>Dr. C. F. Crain was Fellow in Radiology, Sealy-Smith Foundation, at the time the paper was written.

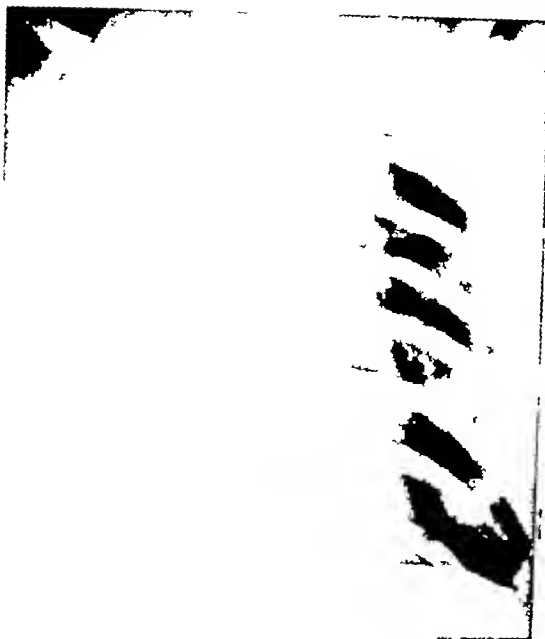


Fig 1 Massive atelectasis (post-operative) Note marked displacement of heart and mediastinum and contracted thorax on affected side. The right dome of the diaphragm is lost in the generalized density of the right thorax.



Fig 2 Same case as shown in Figure 1, two days later



Fig 3 Massive atelectasis (medical). The right dome of the diaphragm is held high. The heart and mediastinum are displaced to the right. The thoracic cage on right is contracted and there is a generalized increased density in the right thorax.



Fig 4 Same case as shown in Figure 3 two days later. There is partial clearing of the density on the right side with an abatement of the other signs.



Fig 5 Same case as shown in Figures 3 and 4, nine days later. The return to normal in 'medical' atelectasis is usually much slower than in the post-operative type.

Fig 6 Lobar pneumonia, two days after onset. The signs of massive atelectasis are present to a lesser degree.

to the case which presents no symptoms whatever.

Physical examination will, in many instances, fail to reveal the true nature of the

process, particularly when the atelectasis is complicating or is complicated by another condition. The roentgen examination then appears to be the procedure of choice by which the correct diagnosis may be established, but even the roentgen diagnosis is not always easy and in many cases will be subject to debate and doubt. Therefore, it behooves the roentgenologist to be ever alert for this condition and, as Bowen has repeatedly emphasized "to think atelectasis."

The silent roentgen findings in massive atelectasis are on the affected side a contracted thorax with a narrowing of the interspaces, the spine curved from the affected side, the diaphragm held high and fixed, the heart, trachea and mediastinal structures displaced toward the affected side and a marked homogeneous density corresponding to the affected part. The opposite side of the chest will show an enlargement of the thoracic cavity with a widening of the interspaces, a depression of the diaphragm and



Fig 7 Same case as shown in Figure 6, seven days later.

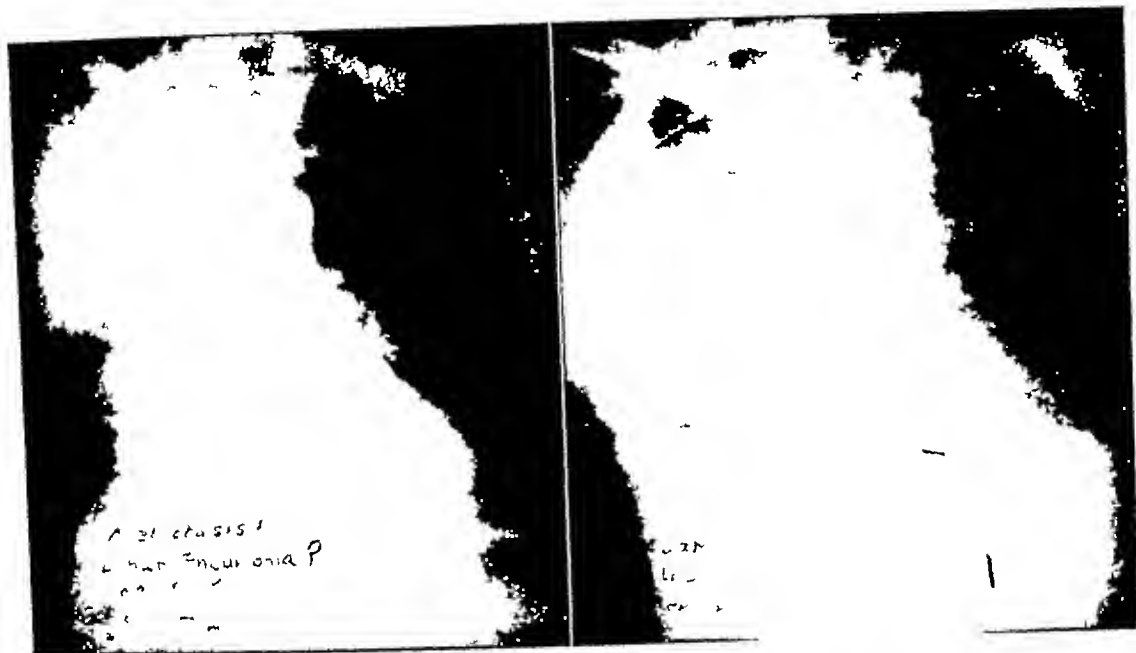


Fig 8. Massive atelectasis. The upper half of the right lung is involved, with a small area in the medial third of the base, obscuring the right heart border. The thorax is contracted, the diaphragm elevated, and the heart and mediastinum displaced toward the affected side.

Fig 9. Same case as shown in Figure 8 only two days later. The areas of pulmonary atelectasis have cleared, the other signs of atelectasis have abated, but there is a lobar consolidation in the middle portion.

an increased radiolucency of the lung. Bowen describes a lateral excursion of the heart with respiration, a pendulum action, whereby with inspiration there is a greater dis-

placement of the heart toward the affected side, while with expiration there is a return to its originally displaced position. He states that in no other condition is there an



Fig 10. Massive atelectasis caused by an obstructed bronchus.

Fig 11. Massive atelectasis from a syphilitic lesion about the hilus.



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The salient roentgen findings in massive atelectasis are on the affected side, a contracted thorax with a narrowing of the interspaces, the spine curved from the affected side, the diaphragm held high and fixed, the heart, trachea and mediastinal structures displaced toward the affected side, and a marked homogeneous density corresponding to the affected part. The opposite side of the chest will show an enlargement of the thoracic cavity with a widening of the interspaces, a depression of the diaphragm and



Fig 7 Same case as shown in Figure 6 seven days later



Fig 16 Later film of same case as shown in Figure 15, showing complete atelectasis on right side



Fig 17 Autopsy specimen of same case as shown in Figures 15 and 16 showing the primary carcinomatous growth in the bronchus

Bowen says that atelectasis must be differentiated from lobar pneumonia, bronchopneumonia, infarct, pneumothorax, subdiaphragmatic abscess, embolism, pleural effusion, and fibroid tuberculosis. Without doubt pneumonia will be the far greater source of error. Coryllos and Birnbaum have compared atelectasis and pneumonia and have reminded us of the similarity of the two conditions, both clinically and roentgenologically. Their views, though extreme, are interesting. They conclude in their studies that etiologically atelectasis and pneumonia have a common basis, *i.e.*, the complete occlusion of a bronchus, the difference being only in the type of the invading organism, which will modify according to the type of organism, the sequence of events following. It is not within the realm of this paper to discuss these points, but one cannot deny that there is a similarity if not a relationship between these two conditions. Bowen has estimated that probably 70 per cent of the cases of so-called post-operative pneumonia are in reality cases of atelectasis.

Aside from an area of increased density in pneumonia, the elevation of the dia-

phragm on the affected side appears to be the most frequent sign common with atelectasis. It is infrequent to find a displacement of the heart, trachea, or mediastinal structures to the extent usually found in atelectasis, but a minor degree of displacement of these structures appears to be quite common. With such striking similarity between the two conditions, it becomes increasingly apparent that the roentgenologist should be on his guard relative to lobar consolidations. A distinction between the two is prognostically and therapeutically of great importance, but it appears that there are cases which from the roentgenological standpoint are borderline.

Massive atelectasis is not likely to be confused with the other conditions which may give rise to one or all of the roentgen signs of it. The diaphragm is seldom found as high as in massive atelectasis, save in subdiaphragmatic abscess or fibroid tuberculosis, differential diagnosis of either of which should not cause difficulty. A slight displacement of the heart and mediastinum is frequently found, but other changes, or lack of changes accompanying it will usually

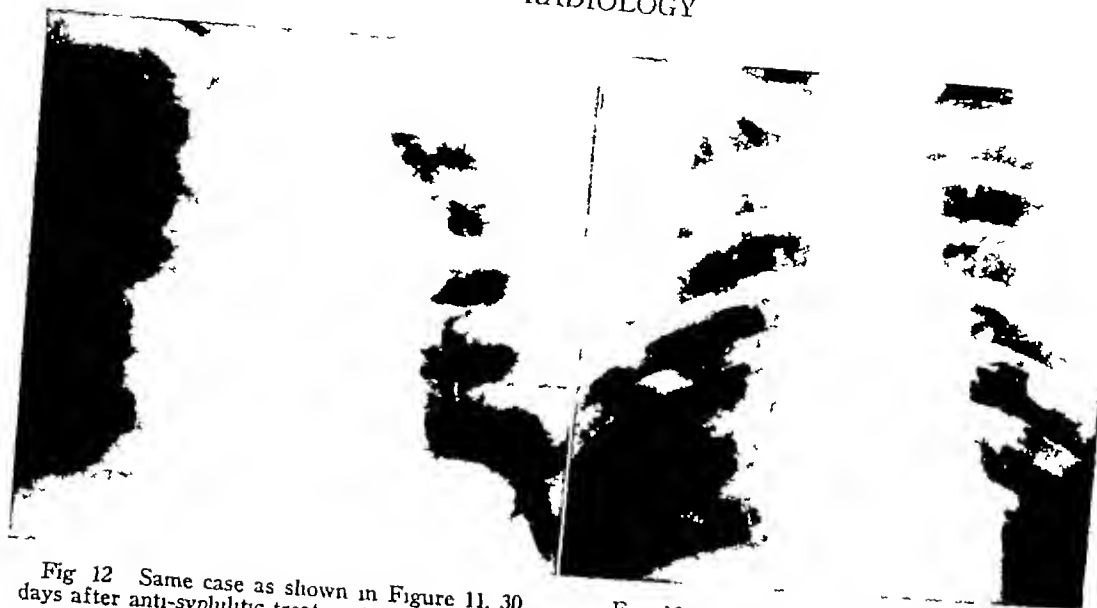


Fig 12 Same case as shown in Figure 11, 30 days after anti-syphilitic treatment was instituted.

appreciable lateral excursion of the heart with respiration.

A typical and uncomplicated case of atelectasis will cause such a striking picture that there is little likelihood of error. However, the more frequent case will probably not present all these characteristic findings to a marked degree. Any of these signs

Fig 13 Metastatic sarcoma in base of right lung

may be present to a greater or lesser extent in other conditions and may be all combined to a lesser extent in an apparently true pneumonia. Errors in interpretation will therefore, be occasioned by any condition which presents all these signs, perhaps in minor degrees, or a few of these signs in a marked degree.



Fig 14 Same case as shown in Figure 13 showing evolution of deposit and development of atelectasis in upper lobe

Fig 15 Massive atelectasis from primary carcinoma of bronchus



# CASE REPORTS

## PRESENTATION OF A CASE OF TUBERCULO-SILICOSIS

ITS ROENTGEN, PATHOLOGIC, AND MINERALOGIC FINDINGS

By PHILIP H. PIERSON, M.D., SAN FRANCISCO

**T**UBERCULO-SILICOSIS is not an unusual condition by any means, but this case presents certain interesting features which warrant its being reported.

(1) The man, aged 46 at the time of his death, April 13, 1932, had worked steadily as a dry driller in quartz dust from 1914 to 1917 and then about one-third of the time during the next seven years. When first seen in 1924, there was evidence of a tuberculous infection in the right apex and hilar glands but no signs of pneumoconiosis.

(2) Serial roentgenograms were taken in 1924, 1925, 1928, 1930, 1931, and 1932, and, beginning with 1925, the gradual development of an extensive nodular infiltration was observed. There was evident difficulty in differentiating whether this was due to a disseminating tuberculosis or to silicosis.

(3) Postmortem examination was performed and the nodules studied both for the cellular reaction and for the presence of silica. The latter, if found, is of value in establishing the diagnosis of silicosis. Its presence indicates that the development of silicosis is not dependent upon a prolonged or constant exposure, also, that even after exposure ceases the latent irritation may go on and produce the final stages of disease.

It is often difficult to distinguish microscopically a tubercle due to silica alone from an early tuberculous tubercle. The experimental work of Gardner (1) (2) working with non-immune and infected animals has shown that the following criteria are helpful.

"(1) Sections should be stained for tubercle bacilli—sometimes they may be present but difficult to find. If found it is evident that in-

fection has taken place, but if not found, the reverse is not so. Animal inoculation is a surer diagnostic criterion.

"(2) True caseation is present more often in the presence of infection, while a hyaline degeneration and fibrosis are often the result of pure silicosis. Here, again, degenerative changes with epithelioid and giant cells may be found in silicosis alone.

"(3) The stages in the development of both are quite similar. Pure silicotic tubercles are composed, first, of clusters of epithelioid cells. As these mature an increasingly heavy reticulum forms, and the cells become compressed and spindle-shaped so that the nodules resemble sarcomatous tissue. Slowly, degenerative changes make their appearance at the center. The fibers swell and stain deeply with eosin, later they become hyaline and most of the nuclei fail to stain. The peripheral zone of lymphocytes, so common in tuberculosis, is not so well developed in silicosis. The margin of the nodule in the latter disease is generally more clearly defined and often demarcated by a definite layer of metaplastic cuboidal epithelium. These are general features which may or may not be present in any given nodule. However, they in general characterize the reaction which occurs apart from infection. In cases in which tuberculosis is superimposed, there is a greater tendency for degeneration to occur and it is often granular rather than hyaline in its appearance."

It is known that dust particles are aspirated into the ductus alveolares and localize, particularly in those lymphatics about rigid structures, such as blood vessels and bronchi where there is less motion than in the more flexible portions of the lung. Tubercle bacilli originally localize in a similar way. The presence of either of these foreign bodies sets up a reaction which eventually becomes fibrotic perhaps caseous and even calcified. This fibrosis will frequently delay or retard a process which might otherwise be more rapid but its disadvantage is

suffice to differentiate between the existing condition and massive atelectasis

A typical case of post-operative massive atelectasis is seen in Figure 1. This illustrates all the cardinal points of the roentgenographic diagnosis. Figure 2 shows the same case two days later.

Figure 3 illustrates the chest which clinically and roentgenologically was considered massive atelectasis. This case was not post-operative, but followed an acute bronchitis. Figures 4 and 5 show the same case two and nine days later, respectively. The similarity of this case to a frank pneumonia is evident on comparing it with Figures 6 and 7. Figure 6 is the roentgenograph of the chest of a pneumonia patient two days after the onset. All the signs of an atelectasis are present but to a minor extent. Figure 7 is the same case seven days later.

Figures 8 and 9 are of the same patient two days apart. Clinically the patient had a pneumonia, though the roentgenographic opinion on the first film was massive atelectasis. This condition of the upper lobe cleared in two days' time, as an atelectasis might be expected to do, but coincident with this clearing there developed a consolidation of the middle lobe on the right side which roentgenographically ran the course of a pneumonia.

Figure 10 is that of an atelectasis produced by the aspiration of a foreign body, a black-eyed pea, which blocked, completely, the left main stem bronchus. No film is available after the bronchoscopic removal.

Figure 11 shows an atelectasis in a case that clinically presented no clue as to the etiology except a positive Wassermann reaction of the blood. Anti-syphilitic treatment was instituted and Figure 12 shows the case thirty days later.

Figure 13 shows a metastatic carcinomatous deposit in the base of the right lung. The evolution of this deposit is seen in Fig-

ure 14, together with an atelectasis of the upper lobe of the right lung, due, undoubtedly, to an occlusion of the upper lobe bronchus by a similar deposit.

Figure 15 shows an atelectasis of the upper portion of the right lung which developed in the course of two months to a complete massive atelectasis of the right lung. The etiology was obscure until, at autopsy, a primary carcinoma of the bronchus was revealed.

#### SUMMARY

1. The salient features in the roentgen-ray study in massive atelectasis are mentioned.
2. The similarity of acute lobar pneumonia to massive atelectasis from the roentgenologic viewpoint is discussed.
3. Films are presented representing different types of atelectasis.

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outcome is the same, whether tuberculosis antedates or follows the aspiration of silica. Many different forms of dust are inhaled

lungs, may not manifest its presence clinically or roentgenologically while engaged in this occupation, and several years may pass

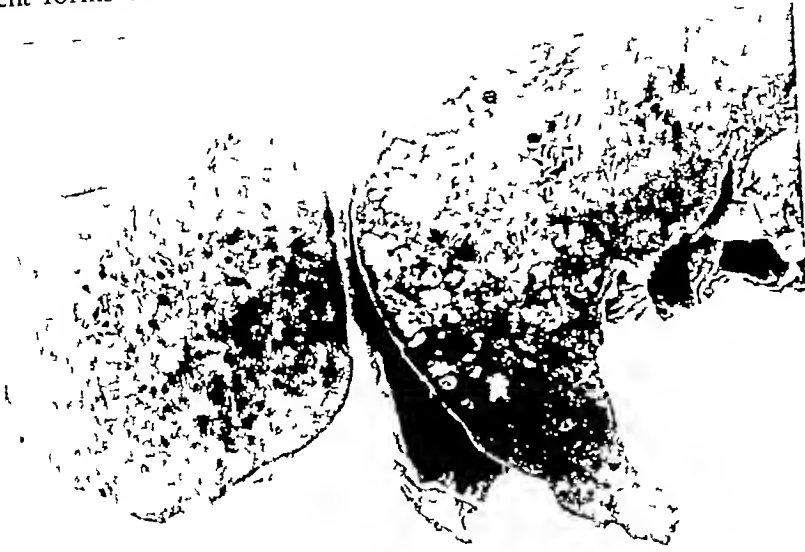


Fig 5 Cross-section of lungs showing lesions of tuberculo-silicosis

and the same reaction is not present in all of them. For instance, coal dust (?) is far less damaging to the lung than free silica. The size, shape, and sharpness of the spicules play important roles in their reaction. The coal is probably more irritating and is consequently "washed" out of the lungs, whereas the silica, with less immediate irritation, remains and sets up the reaction mentioned above. Hefferman (3), in his study of stonemasons, states that a nodular pneumoconiosis does not occur in calcareous workers—those exposed to marble, calc spar, various limestones, Portland stone, Bath stone, Caen stone, Hopton stone, Austin stone, and so forth. Free silica is found in quartz, quartzites, granite, flint, chert, millstone grit, and sandstones in general. Combined silica is present in trap, schists, slates, serpentines, chrysotiles, hornblendes, felspar, basalts, as well as in all clays. Glass is composed of combined silica. It is quite evident then that a worker in silica or any of the above-mentioned forms harboring particles of this substance in his

after his leaving this work before the nodular reaction manifests itself.

#### CASE REPORT

D P, aged 46, married, was first seen at the Stanford Chest Clinic April 17, 1924. By occupation he was a dry driller in a quartz mine where he had worked for three years steadily (from 1914 to 1917) and for about a third of the time during the next seven years. In the latter part of 1924, after being first seen in the clinic, he worked one month at the same type of drilling but never thereafter.

*Present Illness*—He had been in good health, active and strong until six weeks previous to the initial examination when he contracted an acute respiratory infection—a "cold"—and three weeks later expectorated 2 cc of blood on four or five occasions. His cough was dry, he tired easily, had a few night sweats, and was somewhat short of breath. His appetite and digestion were good and his elimination normal. He had no pains in his chest. His best weight four years previously was 160 pounds; his average weight was 155 and his present weight 146 pounds.

The patient's past history was negative and

that an increasing wall of fibrosis excludes the phagocytes which carry off infection and debris. If the inhalation of dust is not too

or roentgenologically, and thereafter its further development may be slow. When the blocking of the lymphatics or tracheo-

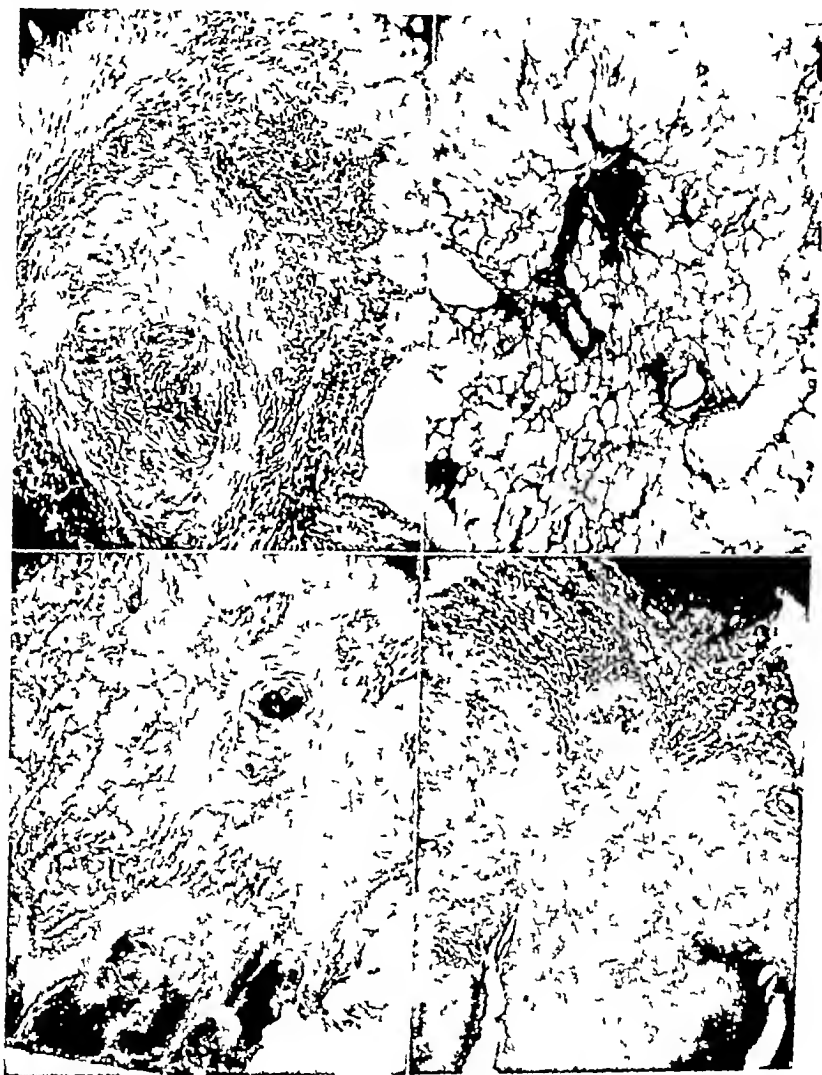


Fig 1 (upper left) Pure silicosis (?) from left upper lobe. Central zone is hyaline rather than necrotic. It is rather sharply demarcated with the peripheral zone composed of small round cells and fibroblasts ( $\times 200$ ).

Fig 2 (upper right) Early localization of foreign material about blood vessels and bronchi, left upper lobe. This accounts for the linear type of scarring seen before nodular areas appear in the roentgenogram ( $\times 50$ ).

Fig 3 (lower left) Infection and silicosis, right lower lobe. Caseation still very slight, fibrosis is marked ( $\times 50$ ).

Fig 4 (lower right) Caseation predominates over silicosis, right lower lobe. Very light repair evident. This is the only section in which tubercle bacilli were found in tissue ( $\times 50$ ).

massive or continuous and if the individual's reaction to his tuberculosis is favorable the development of the fibrosis may be so slow that it takes years to be evident, clinically

bronchial glands eventually becomes complete the peripheral lesions are likely to develop more rapidly and death takes place. From this it can be seen that, in general, the



Fig 8. Film made in 1928.

**Conclusions** It seems likely that tuberculosis has become more widely disseminated throughout the lungs

**Progress Notes**—In July, 1928, he reported as feeling well and weighed 151 pounds. Physical examination then showed some dullness over both apices, with harsh breath sounds over the right apex but no rales were heard

**X-ray examination (July, 1928)**—The cloudiness and mottled density previously noted are more widespread through the lungs than they were at either of the previous examinations, so that at the present time there is scarcely any portion of the lung field on either side which appears normal

**Conclusions** The cloudiness and mottling in the lung fields might be attributed to pneumoconiosis but when studies of the development of the case since April 1924 are made it seems much more likely that the diagnosis of disseminated tuberculosis is the correct one

**Progress Notes**—At this time the intracutaneous tuberculin test with 1/10 mg OT was negative

In April 1929 his weight was 153 pounds

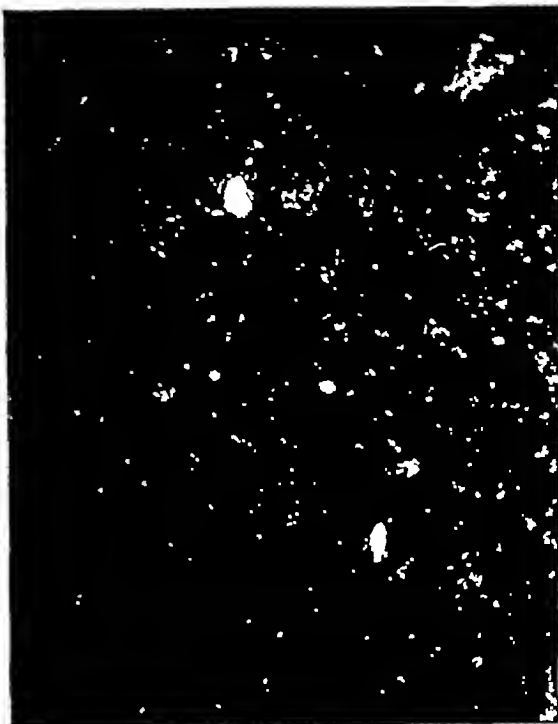


Fig 9 Silica crystals recovered from lung. Photograph made in June, 1932, showing fragments, with ash particles, of which there were two quarts ( $\times 120$ )

he was feeling well, and had less cough than usual. Physical examination of his lungs showed a lag of the left chest and some muscle spasm on the same side. Breath sounds were harsh over both apices. A few scattered râles were heard over both bases only. His sputum showed no tubercle bacilli

He was seen on February 18, 1930, and did not feel so well. He tired easily and felt feverish in the afternoon. He had some cough but almost no expectoration. He had been working on a ranch. His weight was 153 pounds. His lungs showed the same physical signs as before. Intracutaneously 1/10 mg OT produced only a mildly positive reaction. A chart showed that his temperature had been 100° F on two or three days and his sputum showed tubercle bacilli for the first time

**X-ray examination (Feb 18, 1930)**—Since the last examination there has not been a great deal of change in the appearance of the chest except that the disseminated areas appear to stand out a little bit more distinctly. Most of the involvement is in the right upper and mid-



Fig 6 Film made in April, 1924



Fig 7 Film made in 1925

his family history showed no exposure to tuberculosis

*Physical Examination*—Well developed and nourished. Teeth, tonsils, glands, and heart within normal limits. The lungs showed some wasting in the left apex and a slight lag on breathing. Breath sounds were bronchial in character at the right apex but no rales were heard, even with cough. Abdomen and extremities normal.

*Laboratory Tests*—Blood Wassermann was negative. Blood count: Hemoglobin, 72 per cent, white blood cells, 8,000 (differential count: polymorphonuclear cells, 72 per cent; lymphocytes, 27 per cent; transitionals, 1 per cent). Urine was normal except for a slight trace of albumin. Sputum showed no tubercle bacilli.

*X-ray examination (April 19, 1924)*—"The rib cage is fairly symmetrical with a slight compression of the left top apparently due to a slight scoliosis in the upper thoracic spine. There are well-marked pleural scars across both apices and within the right apex there is an area of pneumonic density with increased density in the bronchial tree branches and

with altogether the characteristic x-ray appearance of tuberculosis. Both lung roots are abnormally heavy and the right hilum includes a large calcification. There is thickening of the pleura between the lobes of the right lung. The heart vessel shadow is not remarkable.

*Conclusions*—Tuberculosis, very marked, in the right upper, and probably present also in the left apex and both lung roots."

*Progress Notes*—After hospitalization for two months the patient's weight increased to 152 pounds. In October 1925 he was doing a full day's work as a farm laborer and his weight was 147. He complained of some cough and dyspnea. His physical signs were as before.

*X-ray examination (Oct 5, 1925)*—"There is a slight but definite irregular clouding throughout both lung fields, a generalized involvement which was not noted a year and a half ago. On review of the old films however it is seen that there was at that time a faint suggestion of the same clouding at least in the right lower lobe. Evidence of consolidation at the right apex persists and the left apex is still only gray.

density which suggests cavitation. No other cavities are noted.

**Conclusions** In spite of the history of old tuberculous infection in the apices, and in spite of the rather rapid development of the disseminated densities, the character of the lesions as shown by the x-ray examination suggests that the patient's condition is largely due to pneumoconiosis and not to disseminated tuberculosis. Of course, there is undoubtedly some tuberculosis present as well, and the suggestive cavitation on the left side is probably tuberculous.

**Progress Notes**—In February, 1932, he went to a county sanatorium, where his tem-

perature ranged from 99 to 100°. He steadily became worse and died April 13, 1932.

#### CONCLUSIONS

1 Silicosis in this case did not make its appearance roentgenologically or clinically until after a period of five or six years of mining, a total time of ten years from the beginning of the patient's exposure to silica dust.

2 Its progress is noted in serial roentgenograms taken over a period of seven years.

3 Pathologic study shows that most of the lesions were due to combined silicosis

#### ANALYSIS

	Left Base	Right Base	Left Apex	Right Apex
Dry sample (grams).....	0.908	1.322	2.160	0.883
Ash (grams).....	0.0456	0.0637	0.0801	0.0341
SiO <sub>2</sub> (grams).....	0.0178	0.0267	0.0286	0.0124
Ash in sample %.....	5.03	4.82	3.70	4.10
SiO <sub>2</sub> in sample %.....	1.96	2.02	1.32	1.49
SiO <sub>2</sub> in sample %.....	39.0	41.9	35.7	36.4

and tuberculosis and their general reaction in the lung was very similar.

4 The spread of tuberculosis took place only when the fibrosis due to the two conditions had interfered with the normal phagocytic reaction.

5 The fact that silica was basically responsible for this appearance is shown by the fact that approximately the same percentage of silica is present in all parts of the lung.

6 This case presents an industrial problem. In cases in which silica has been inhaled the roentgenogram may not show the reaction to it for some time, and, hence, liability may be determined only after a waiting period has passed.

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**Autopsy**—Sections were taken from several parts of the lungs and the pathology showed all stages, from what appeared to be pure silicosis to areas where tuberculosis dominated the lesion. The accompanying illustrations show characteristic sections. Sections were removed from each apex and base and were analyzed by a mineralogist for the presence of silica. The following is his report:

**Determination of Silica in Lung Tissue**—The samples to be analyzed, which were suspended in salt solution, were squeezed as dry as possible between paper towels, cut into small pieces, and dried to constant weight (about 6 hours) at 70° C. They were burned and ignited in a 100 c.c. platinum dish over a Meker burner, and the ash weighed. Since sulphuric acid was necessary in the subsequent treatment with hydrofluoric acid, the ash was treated with sulphuric acid and again ignited. The resulting weight (which differed only slightly from that of the untreated ash) being used in calculating silica content. The ash was



Fig 10 Film made in 1930



Fig 11 Film made in 1931

dle lobes, and in the left upper lobe, leaving the lower lobes relatively clear, but probably not absolutely free. No tubercle-like areas are seen in the region of the spleen, therefore, this has been a tuberculosis disseminated through the lymphatics, rather than a military tuberculosis, spread through the blood stream.

**Conclusion** Disseminated tuberculosis, which has not advanced in the past year and a half.

**Progress Notes**—He then spent fourteen months at the Hillcrest Sanatorium, where another sputum examination was positive. While there he had a small hemorrhage. The medical examiner of the sanatorium stated that the physical examination showed "very indefinite signs in his lungs; impaired resonance on the right to the second rib; impaired breath sounds with indefinite signs of cavity at the second dorsal spine on the right, but no rales were heard."

The patient reported again on May 19 1931 saying that he had a slight cough and expectoration, no night sweats, fever or fatigue, but some indefinite pains in his chest. Physical examination showed restricted motion in both

lungs, some dullness over both upper lobes, and a few fine rales over the upper lobes on both sides, the right more than the left. His temperature record showed no fever and his blood sedimentation curve was that of a quiescent case. His sputum was negative for tubercle bacilli. On Sept 22 and again on Oct 22 1931 he reported as having pains on both sides of the chest with deep breathing. A dry cough was present and he was more easily fatigued. His weight had fallen to 144 pounds. Physical examination showed some dullness at both apices with a few fine crepitant rales over the left apex posteriorly. There were distant breath sounds and a few pleural crepitations in his left axilla and a pleural rub near his right hilus posteriorly. His sputum was positive for tubercle bacilli.

**X-ray examination (September 1931)**—Since the last examination there has been increase in distribution and size of the disseminated areas of density, so that practically the entire lung field now presents a snowflake appearance. The calcification at the upper right lung root has not changed. Behind the left fourth rib there is a small area of decreased



is soft and there remains only a small scar. The glands show no enlargement and after a year and a half the patient seems in good health.

**Case 2** This is a case of basal-cell epithelioma of the eyelid in a man 81 years of age.

*History*—The lesion on the left eyelid made its appearance about three months before the date of my examination on Dec 6, 1932. It seemed to be a small pimple and was treated by the man's family physician with ointments.

Upon examination it was seen to have grown to an elevated mass measuring  $2 \times 2$  cm in diameter, with a necrotic center and overhanging edges. A diagnosis was made of basal-cell epithelioma. Before beginning treatment a photograph (Fig 3) was taken of the growth.

*Treatment*—Under local anesthesia by butyn, fulguration was done of the necrotic center and under the edges, down to the meibomian cartilage. This was followed by what amounted to about three erythema doses of x-rays (9-inch spark gap, 4 ma, 0.5 mm of Al, 10-inch distance, 15 min), during which the eye was carefully protected with heavy lead foil. X-ray treatment was repeated on Dec 13 and again on Dec 27, a total of seven erythema doses being given. Following each treatment the area was touched with mercuriochrome.

When the patient was last seen (Fig 4), four months after the initial treatment, the area appeared to be completely healed, the skin was normal, and there remained only some conjunctivitis.

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## ANNOUNCEMENT

The papers read before the Congress have been divided on an equitable basis between the publications of the American Roentgen Ray Society and the Radium Society and

the Radiological Society of North America, and RADIOLOGY expects to publish a considerable number of them during the coming year.

# BASAL-CELL EPITHELIOMA TWO CASE REPORTS

By JOHN S. DERR, M.D., FREDERICK, MARYLAND

**Case 1** This is a case of basal-cell epithelioma of the lip, treated with combined electrocoagulation and x-rays. The patient

scopic examination would not alter the indications for treatment, none was made. There were no palpable glands in the submaxillary or submental regions. Before treatment was begun, photographs were made of the growth (Fig 1).

**Treatment**—After anesthetization by a



Figs 1 and 2 (above) Basal cell epithelioma of the lip showing lesion and end-result after treatment (Case 1)  
Figs 3 and 4 (below) Basal-cell epithelioma of the eyelid, showing end result. (Case 2)

was a white male, aged 66, who came for treatment June 27, 1931.

**History**—About a year previous to examination, while the man was being shaved, the barber, with his finger nail, cut the patient's lower lip. The abrasion did not heal promptly, and was treated with ointment. A growth then began in the wound which gradually increased in size until it covered practically the whole lower lip and hung over to the crease of the chin, upon examination, it measured  $5 \times 3 \times 1.05$  square centimeters.

**Examination**—The mass showed ulceration of the surface of the mucous membrane extending down inside the lip although the mass of the growth which hung far below its attachment was not ulcerated.

**Diagnosis**—It had all the appearance of a basal-cell epithelioma, and since a micro-

hypodermic injection of 1 per cent butyn a considerable portion of the growth was destroyed by electrocoagulation at the first sitting. This was followed by cross-firing with x-rays, the technic being a 9-inch spark gap, 4 ma, 0.5 mm Al filter, 9-inch distance. The mouth was protected with lead foil on the inside of the lip. The total time of this first treatment was 20 minutes.

A second x-ray treatment was given on the lip while the glands of the neck were four times cross-fired in three directions using a filter of 6 mm of Al. The estimated dosage to the lip was five erythema doses.

**Result**—After a moderately severe local reaction the healing was progressive and continuous. Four months after the first examination a second photograph (Fig 2) was taken showing a complete reduction of the growth. At present the mucous membrane of the lip

the public that medical training is not essential. In many instances, physicians themselves patronize lay laboratories, thus fostering them. Often lay-controlled laboratories hire physicians to sign their reports while the actual work, even the interpretations, is done by lay persons. This constitutes somewhat of a problem in certification.

Since most of the branches of medicine look to the specialty of radiology for important aid in diagnosis and treatment, the careful certification of qualified physicians should be made to protect the patient and the profession. A powerful influence in the regulation of those qualified is, of course, a membership in special radiologic societies. The societies immediately bar the lay practitioner and, to a certain extent, the physician who has not had adequate training and experience, they do, however, admit men whose major work is in other specialties. This is notably true of some surgeons who also use radiology. It is obviously difficult to know where to draw the line, since it is certainly admitted that a physician may be proficient in more than one specialty.

The American Medical Association has assisted in placing the specialty of radiology on a par with the other specialties through its hospital work. Requirements regarding radiologic service are included in essentials for registered hospitals, hospitals approved for internships and hospitals approved for residencies in specialties.

In 1928 the House of Delegates of the American Medical Association received requests from sections on radiology of several medical societies for supervision of laboratories of roentgenology and radiology similar to that already established over clinical laboratories. The request was granted and a committee of radiologists outlined the plan of procedure. Essentials were established and an adequate questionnaire was formulated and distributed. After carefully checking each candidate in the biographic files and records of the American Medical Association,

from advisers (who are outstanding radiologists in various sections), a tentative list of physicians conducting approved laboratories or departments of radiology or roentgenology was published on May 23, 1931. The Council will maintain this list as an active part of the work. Additions and revisions will be made from time to time, suggestions for changes and consideration of new applications will go on continuously. Co-operation by the men in the specialty has been excellent and must continue in order that the work may be of optimum value.

The committee of radiologists logically places stress upon the personnel of an approved department of radiology or roentgenology. The director and other physicians in the department are considered consultants by the profession, and, as consultants, they are practising medicine and should be licensed in the State in which they do their work.

The Council has understood from the very beginning, and has advocated the principle that the practice of radiology and roentgenology is the practice of medicine. It has followed this principle in the interpretation of the essentials, in the preparation of its lists, and in every opportunity that it has had to express itself on this point to the entire medical profession.

The Council requires that roentgen-ray facilities and records shall be adequate. Publications containing the requirements as well as several other pamphlets on radiologic service in hospitals have repeatedly been sent to every hospital in the United States and have been in use for many years. The essentials of a hospital approved for residencies in specialties having the same requirements except in cases in which the special training is in the field of roentgenology have been sent to several hundred hospitals that have applied for approval for residencies in specialties.

# EDITORIAL

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BUNDY ALLEN, M.D.

Editor  
Associate Editor

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## PROBLEMS IN CERTIFICATION OF RADIOLOGISTS<sup>1</sup>

The *Bulletin of the American Medical Association* recently reported that approximately 40 per cent of recent graduates limit their practice to a specialty and another 40 per cent are giving particular attention to a specialty. Undoubtedly a great many of these physicians do not have the desired qualifications. This is true in the specialty of radiology as it is in most other specialties.

According to the directory, 1,783 physicians limit their practice or give special attention to radium therapy and roentgenology. This group occupies the eighth place in numbers of physicians in the twenty-five specialties listed. The youngest specialty already embraces 37 per cent of all physicians designating themselves as specialists.

The tendency of recent graduates to elect specialties rather than general practice is important in our consideration. Medical students to-day are evidently imbued with the idea that the science of medicine is so extensive that no one person can hope to compass the whole subject, and, therefore each one should try to limit himself to some particular branch.

Often a recent graduate, with no broad preliminary training or with only a few weeks' training in a post-graduate course

holds himself out as a radiologist or roentgenologist, thus the pseudo-specialist in roentgenology appears. Dr J. B. Herrick states in an article appearing in *The Journal* that, "when the profession fails to keep the ideal of benefit to the patient before it, practice will degenerate and will be in essence dishonest." It may possibly be construed as dishonest to hold oneself out as having superior knowledge and training in a certain branch (which is often the impression received by the public) when training has not actually been consummated. That danger attaches to the physician who is specialist in name only, who is poorly prepared, and lacks proper graduate study and broad experience.

Objections to too much specialization are evidenced in the literature of the past few years and should constitute an argument in favor of certification of those specialists who have the proper qualifications. Objections in the main are not against the institution of specialization for this progress is inevitable, but are directed against the self-appointed or pseudo-specialist, who has had only a minimum, or no post-graduate experience.

The field of radiology seems to be especially attractive to the recent graduate as well as to the ambitious lay person for the reason that mechanical devices are employed. To the uninformed public it appears that little training or special knowledge is necessary. You know possibly better than I do the number of lay persons trained as technicians who have established radiologic laboratories and who often attempt to give the impression that they are medically competent. The group attempts to convert this special branch of medicine into a trade and to carry an impression to

<sup>1</sup>Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

## PAST-PRESIDENT BYRON H JACKSON, M D

The term of office which ended with the Congress of Radiology in September has revealed the able leadership of Byron H Jackson, M D, of Scranton, Pennsylvania. Intimately acquainted as he is with the executive acts and scientific progress of all the radiological societies, Dr Jackson's official acts and personal influence have contributed to the development of new apparatus, to clearing up what has come to be called "the tube situation," to promoting a spirit of fellowship among radiologists, and to the extension of education in radiology in medical colleges.

In addition to a genius for friendship, Dr Jackson has in a high degree the power of inspiring confidence in his associates. To the honorary posts already filled by him, he has now added that of Past-President of the Radiological Society of North America. Also, he has been chosen as a six-year member of the Qualifying Board, upon which he represents the American College of Radiology. This Board will act in an advisory capacity to standardize the education of those who would specialize in the practice of radiology.

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## RECOLLECTIONS OF THE AMERICAN CONGRESS OF RADIOLOGY

The first American Congress of Radiology—what is the verdict? Was its object achieved? Did it come up to the expectation of its creators and of its members? Has it paved the way for a unified group meeting of all the interested bodies in the near future?

To the writer, these questions can all be answered in the affirmative.

The Congress will likely mark an epoch in the development of radiology in this country.

No yearly meeting has ever assembled such exhibits either of clinical material or apparatus, indeed, a five-year advance would seem to have been made. It is said to have been the largest of its kind and to represent adequately the rapid progress being made in radiology.

As to its practicability there can be no argument. Socially it was all that could be desired. From an economic viewpoint, it saved many members the time and expense of two journeys.

The American manufacturers of apparatus of all standard types, equalling or perhaps surpassing any made in the world, were represented by splendid collections, which were of distinct advantage to the radiologists present. The N V Philips Company, of Eindhoven, Holland, brought over an extensive exhibition of their products.

It is to be hoped most sincerely that those who direct the policies of the various radiological bodies will seriously consider the question of a feasible simultaneous group meeting. Such an act will earn the everlasting gratitude of all concerned. If one may venture a suggestion, these proposed annual meetings could well be held in the fall as far removed as possible both in time and place from the annual meeting of the American Medical Association.

The Chicago Congress will live in history. Its official program, the book "Science of Radiology"—its portrait catalogue, veritable reference works of the highest order, will serve as treasured mementoes. The committee in charge catalogued the exhibit adequately, while the rare books were reviewed in an interesting style.

Much credit is due the committees whose untiring work made the Congress possible and under whose capable management it functioned so smoothly. To Benjamin H Orndoff, M D, especial acknowledgment is due.

ALBERT S. JONES, M D

interns are that the department be equipped for at least roentgenographic and roentgenoscopic procedures and be directed by a physician-roentgenologist who is properly qualified for the work which the department purports to do. Records must be on file in the department, and copies should be filed with the clinical charts. The Council has never endorsed a hospital or other medical institution in any way when it was known that lay specialists were employed for roentgen-ray interpretation or therapy.

While no revolutionary changes could be expected in so short a time, we can be sure that much has been done by way of education through constant publication of requirements, their enforcement, so far as reasonably possible, and through first-hand inspection of over a thousand hospitals and laboratories.

Doubtless the chief reason radiologists requested an investigation and the publication of a list of those found competent was the tendency of unqualified individuals, both medical and lay, to hold themselves out as specialists in radiology. Many problems are involved in making up such a list, a few of which I shall mention.

1 *Should the list be comprehensive and embrace all men trained in roentgenology whether or not they are available to the general profession for consultation?*

If it is to be a complete list physicians in the Army Navy Veterans' Administration United States Public Health Service medical colleges and various governmental laboratories should be included. These physicians are specialists to the same degree as those who are offering their services to the general profession in commercial laboratories or hospitals.

2 *If the list is to include all who qualify regardless of position, should it be constructed in such a way as to designate those who offer their services to the profession and those who are in administrative capacities or in governmental service?*

3 *Should the list of radiologists and roentgenologists include the names of men who designate other specialties for themselves in the American Medical Directory?*

The American Medical Association has not yet set the precedent of allowing a physician to designate himself in the directory under more than one specialty. It would seem to be inconsistent for a physician's name to appear on a list of radiologists and at the same time to be under some other specialty. There are a number of applications from physicians who have designated their specialties as other than radiology, such as surgery, internal medicine, or clinical pathology. They may devote from one to four hours a day to radiologic work and qualify in training and experience, but a substantial amount of their time is devoted to, and their main interest lies in, another specialty. While these men are worthy of favorable consideration, in order to be consistent it may be necessary that their designation in the directory be changed to radiology.

4 *Should physicians employed by lay organizations be considered?*

The main objection in the consideration of such candidates is that too often lay-controlled laboratories use unfair methods of advertising and price-cutting.

Without doubt the Council's work will have, and has had a good effect on this situation, but the work of establishing reliable lists and of checking the laymen and other incompetents has only begun.

The Council appreciates the splendid cooperation of the men in roentgenology and radiology who have made this survey possible. It is especially grateful to those men who serve as the advisory committee in the various sections. These men have cheerfully lent their efforts and time to the Council to obtain first-hand information concerning applicants for listing.

O. V. ANDERSEN, M.D.

autopsy showed 1 in 10 deaths to be due to pelvic cellulitis, a 10 per cent rate.

Therefore, in performing suprapubic cystotomy with his technic, which establishes adequate drainage of the space of Retzius and the wound, perivesical suppuration can be prevented, and is not and should not be the predominant dangerous complication and the prime cause of death

DAVIS H. PARDOLL, M.D.

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Traumatic Ulcer of the Duodenum and Stomach  
Burrill B. Crohn and Julius Gerendasy Jour Am Med Assn., May 27, 1933, C, 1653-1658.

German and French literatures are replete with illustrative examples and references and not only recognize the existence of this entity, but describe in detail the *modus operandi* of the trauma, the clinical manifestations that accompany the formation of the lesion, and the clinical course of this unusual ulcer syndrome. A woman, aged 45, with no history of previous digestive disturbances or complaints, was violently thrown out of a seat of a bus, catapulted across the aisle, so that the epigastric area of the abdomen forcibly struck a projecting edge of the opposite bench. She complained of the pain but was able to proceed to her home. The next morning she felt a less severe epigastric distress, on evacuation of the bowel she noted that the stools were black. Two days later, she felt nauseated and vomited a large quantity of blood. Upon the woman being removed to a hospital, the hematemesis was repeated several times, associated with melena. The subsequent course of the case has been characteristic of a typical duodenal ulceration. Roentgenographic studies corroborated the presence of a duodenal ulcer. After a two-year period the persistence and severity of the symptoms brought up the question of surgical intervention.

A comprehensive review of the literature leads to the conclusion that traumatic ulcer of the stomach and duodenum does exist.

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stance in each 60 c.c. bottle, and had consumed about 1,400 bottles. During the few months he was in the hospital the air he expired was found to be radio-active. Four weeks before death a part of the jaw, which was necrotic, was removed by operation. The autopsy revealed necrosis of the jaw bones, swollen kidney cortex, cerebral abscess of the right temporosphenoidal lobe, moderate coronary sclerosis of the aorta, and marked hyperplastic bone marrow (regenerative type) (bright red bone marrow). The heart, liver, lungs, spleen, and kidneys and portions of the femur, vertebrae, ribs, jaw bone, and teeth were taken for analysis. The preparation and examination of these tissues are taken up in detail. The presence of radium was proved by both the electroscopic and the photographic methods. The total amount of radium in the entire body was 73.66 micrograms.

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C. G. SUTHERLAND, M.D.

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shadow of definitely increased density when compared with the shaft. In five cases on the other hand, as time progressed more and more mottling developed distributed irregularly throughout the proximal fragment. In two cases a well-pronounced wedge-shaped area of localized resorptive rarefaction extended inward with the base of the wedge at the fovea. Except for this area, the density of the remaining portion of the proximal fragment was increased.

In the 15 cases in which non-union resulted early beginning absorption of the femoral neck was noted. Subsequent roentgenograms taken at regular intervals in each instance showed that, once resorption in the area of the neck began, it progressed until the entire neck had disappeared. Later the fractured surfaces became capped by sclerotic bone, which showed in the roentgenograms as lines of definitely increased density. The author concludes that the ligamentum teres carries a definite blood supply to the head of the femur regardless of the age of the subject. This blood supply is a definite factor in maintaining the nourishment of the head of the femur in cases of intracapsular fracture. Operations for repair of non-union in the neck of the femur should be planned and executed in a manner which will not disturb or injure the vessels coming through the ligamentum teres nor should foreign material approximate too closely the foveal area.

CHARLES G SUTHERLAND, MD

## FRACTURES (THERAPY)

Circulation of the Head and Neck of the Femur Its Relation to Non-union in Fractures of the Femoral Neck. W Eugene Wolcott Jour Am Med Assn, Jan 7, 1933, C, 27

Since the appearance of Santos publication in 1930 a careful study of all x-ray films has been made in 79 cases of fracture of the hip. In no instance was there roentgen evidence of necrosis of the head or neck of the femur among 38 intertrochanteric fractures. Throughout the entire number of roentgen examinations in these cases, the relative density of the fragments of the head and neck seemed to remain constant with that of the shaft. Of the intracapsular group however, in 11 cases in which non union existed, definite changes in the relative density of the free head and the upper shaft were seen. In six of these the femoral head existed

## THE PELVIS

Suprapubic Cystotomy and the Prevention of Pelvic Cellulitis L T Mann Am Jour Surg March, 1933, LXV, 505-508

The author finds that only 8 per cent of autopsied cases in his series died of perivesical suppuration, which is not in keeping with the opinions of other authors that this is the main cause of death in suprapubic cystotomy. Twenty four autopsies were on prostatectomized cases. Two died of pelvic cellulitis which is 8.3 per cent of the autopsied or 0.3 per cent of all prostatectomies. Of 16 deaths after simple cystotomy for relief of prostatic obstruction in which autopsy was done, one (6.2 per cent) died of perivesical suppuration.

Finally, of those who died after suprapubic cystotomy for conditions other than prostatic adenoma



autopsy showed 1 in 10 deaths to be due to pelvic cellulitis, a 10 per cent rate.

Therefore, in performing suprapubic cystotomy with his technic, which establishes adequate drainage of the space of Retzius and the wound, perivesical suppuration can be prevented, and is not and should not be the predominant dangerous complication and the prime cause of death

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Sacs, Pockets, and Localized Hypertrophy of the Mucosa in the Post operative Stomach R. Prevot *Röntgenpraxis*, February, 1933, V, 101-107

Post operative disturbances in a stomach after resection or gastro enterostomy need roentgenologic examination in order to clear up the anatomical or functional factors. The formation of sacs, pockets, and localized hypertrophy of the mucosa has been described by Berg, but has not received the attention it deserves.

Localized dilations of the jejunum opposite the anastomosis with an intact mucosa are called sacs by the author. The explanation of this is probably that the loop of the jejunum, stretched during the operation and in a relaxed condition, retracts again and forms a localized dilated sac. If the sac is large enough, some degree of temporary retention will develop and occasionally this sac may be larger than the rest of the stomach. Scar tissue or too high insertion of the enterostomy may lead to inflammatory swelling and gastro jejunal ulcer. The patient's symptoms are dependent on the secondary inflammatory changes and the size of the sac that is mechanical factors. They are loss of appetite, the feeling of fullness after a meal, pain and tenderness in the epigastrium, nausea and occasionally vomiting. The roentgenologic examination shows the sac formation with an intact mucosa.

Pockets are also localized dilations but do not show any mucosa relief, they are according to Berg similar to the pockets seen in the duodenum after a duodenal ulcer, and caused by inflammatory changes and scar tissue (prestenotic diverticula). The symptoms in these cases are due to the inflammatory changes and are of the gastro jejunal ulcer type.

Localized areas of hypertrophied mucosa are occasionally found in the neighborhood of the anastomosis after gastric resections of the Billroth II type. Their occurrence can be explained by the operative technique which leaves too much mucosa at the anastomosis. Inflammatory changes will increase the size of these folds so that sometimes they represent a considerable obstruction which might act as a valve occluding the enterostomy-stoma completely at times. The clinical symptoms are the feeling of fullness even after small meals, pressure over the stomach, nausea, and vomiting. The roentgenologic picture is that of a well circumscribed round filling defect, occasionally a carcinomatous recurrence or enlarged glands pressing on the stomach from the outside may cause the same appearance.

H. W. HEFKE, M.D.

## ULTRA-VIOLET LIGHT

Studies on the Significance of Pigment for the Ultra violet Light Protection of the Skin G. Miescher *Strahlentherapie*, 1932, XLV, 201-216

The pigment of the skin is not the principal factor in light protection, the upper layer of the epidermis is perhaps more important, since it responds to light exposure by thickening and thus shields the underlying tissue. However, pigment has some protective properties. The author showed in his studies, undertaken on animal skin and on negroes, that pigment absorbs short ultra violet rays strongly. The difference in absorption between white and negro skin is apparently due to the larger pigment content of the latter.

ERNST A. POHLE, M.D. Ph.D.

Dermatologic Findings in Light Reactions of the Skin under the Influence of Stuchruch-Herrmannsdorfer-Gersonsche (S.H.G.) Diet Max Popper *Strahlentherapie*, 1932, XLV, 235-246

The author studied the skin capillaries in areas exposed to ultra violet light in patients who were on the S.H.G. diet. It appeared that there existed an increased susceptibility in the skin manifesting itself in more severe reactions of longer duration. This can be explained in all probability by an influence of the diet on the blood vessels. There were capillary hematomas and dilatation of the deeper blood vessels.

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The Behavior of the Skin Elasticity during Pregnancy and Its Change Following Ultra-violet Exposure H. Guthmann, F. Anselm, and H. Papenberg *Strahlentherapie*, 1932, XLIV, 443-474

During pregnancy the calcium content of the blood serum is definitely lower causing disturbances of the colloid equilibrium in the cells. This leads to a loss of fluid, manifesting itself in a loss of elasticity, which can be shown also in the skin. This phenomenon reaches a maximum in the third month, and then drops until the sixth month, when it begins to rise again, reaching its highest peak toward the end of the pregnancy. Short time intensive ultra-violet exposure influences the calcium and potassium metabolism so much that this loss of elasticity can be counteracted. The effect of the irradiation lasts about four weeks. The prophylactic ultra-violet exposure of pregnant women is, therefore recommended.

ERNST A. POHLE, M.D. Ph.D.

# *X-Ray Industry Now Operating Under NRA Code*



● The x-ray profession is assuredly interested in learning that the group of manufacturers listed below, representing a majority of interests in the x-ray industry, is now operating under the general provision of the electrical code as adopted by the National Electrical Manufacturers Association and approved by the President as of August 4, 1933. A supplemental code of Fair Trade Practices effective as of August 26, 1933 has been agreed upon and subscribed to by the same group of x-ray manufacturers. This has also been submitted to other organizations who may be considered as a part of the x-ray industry, and there is every reason to believe that it will also meet with their full approval. The reduction and relief of unemployment, the improvement of standards of labor, the rehabilitation of industry, the elimination of unfair competitive practices—these are the aims of President Roosevelt and his Cabinet, to which we have wholeheartedly pledged ourselves in the adoption of this Code. Looking toward a full realization of the many benefits which the National Industrial Recovery Act seeks for every man, woman and child in the United States, we have adopted the NRA emblem and the principles for which it stands.

GENERAL ELECTRIC X-RAY CORPORATION  
WESTINGHOUSE X RAY COMPANY, Inc.  
THE KELLEY-KOETT MFG CO., Inc.  
PICKER X-RAY CORPORATION  
WAITE & BARTLETT X-RAY MFG COMPANY  
STANDARD X-RAY COMPANY  
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# LIPIODOL (Lafay)\*

The Original Iodized Oil  
Council Accepted  
Technique of Injection



*Seminal vesicles. Normal. Lipiodol diluted with paraffin oil. Injection of 2 c.c. by inguinal route after dissection of spermatic cord and catheterism of vas deferens. Both sides injected both visualized. The vasa are quite visible as well as the delicate contours of the vesicles. An excess of Lipiodol had run into the bladder but it was voided with the urine previous to radiography.*

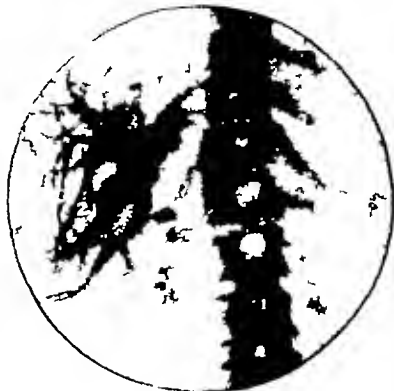
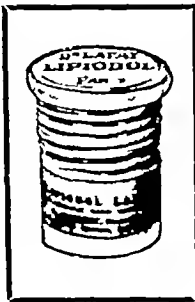
Photograph from Sicard and Forestier

## SEMINAL VESICLES

Sicard and Forestier mention two routes which may be chosen for the injection

- 1 The natural via the urethra after catheterization of the ejaculatory ducts through the urethroscope. The technique of this injection does not differ from the one used by urologists in irrigating the vesicles through the ejaculatory ducts
- 2 The surgical, via the inguinal canal after exposure of the spermatic cord. The skin is disinfected and anesthetized at the level of the scrotum. A short incision is made, the cord is exposed and dissected by means of a grooved director. Then having carried the local anesthesia to a greater depth, the vas is liberated and a small trocar, 5/10 mm in diameter is inserted through its wall, axially and upwards in the directions of the vesicles. A syringe with Lipiodol is attached to the trocar and the oil is injected.

Pure Lipiodol is too viscous for this purpose and Sicard and Forestier recommend its dilution with paraffin oil. A dose of 2 to 3 c.c. is generally sufficient to outline the vesicles. The injection is quite painless.



*Illustrating injection through abdominal postoperative biliary fistula of two months duration with incomplete stricture of the common duct. 1 Tube in sinus tract. 2 Stump of gall bladder. 3 Common duct with small quantity of Lipiodol passing into duodenum. The hepatic ducts down to the very fine intrahepatic biliary radicles are outlined due to reverse flow above the stricture.*

Photo Ginzburg and Benjamin

## BILIARY FISTULAE

Ginzberg and Benjamin recommend the following procedure

Prior to the injection, the Lipiodol is warmed and whatever bile is present in the sinus is aspirated. If a tube is still in situ, gravity will suffice to outline the ducts. The tube should be removed before a plate is taken as it may obscure the picture. Where the skin opening is small and the tract is narrow and tortuous it is frequently necessary to use some degree of pressure in order to force the Lipiodol into the duct system. A syringe with a rubber urethral tip attached to the nozzle should be used.

The skin should always be wiped dry of Lipiodol before the plate is taken or confusing shadows will appear.

In order to prevent the escape of the injected fluid the sinus should be plugged and strapped over.

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## Technique of Injection



*Seminal vesicles. Normal. Lipiodol diluted with paraffin oil. Injection of 2 c.c. by inguinal route after dissection of spermatic cord and catheterism of vas deferens. Both sides injected both visualized. The vasa are quite visible as well as the delicate contours of the vesicles. An excess of Lipiodol had run into the bladder but it was voided with the urine previous to radiography.*

*Photograph from Sicard and Forestier*

*Illustrating injection through abdominal postoperative biliary fistula of two months duration with incomplete structure of the common duct. 1 Tube in sinus tract. 2 Stump of gall bladder. 3 Common duct with small quantity of Lipiodol passing into duodenum. The hepatic ducts down to the very fine intrahepatic biliary radiels are outlined due to reverse flow above the stricture.*

*Photo Ginzburg and Benjamin*

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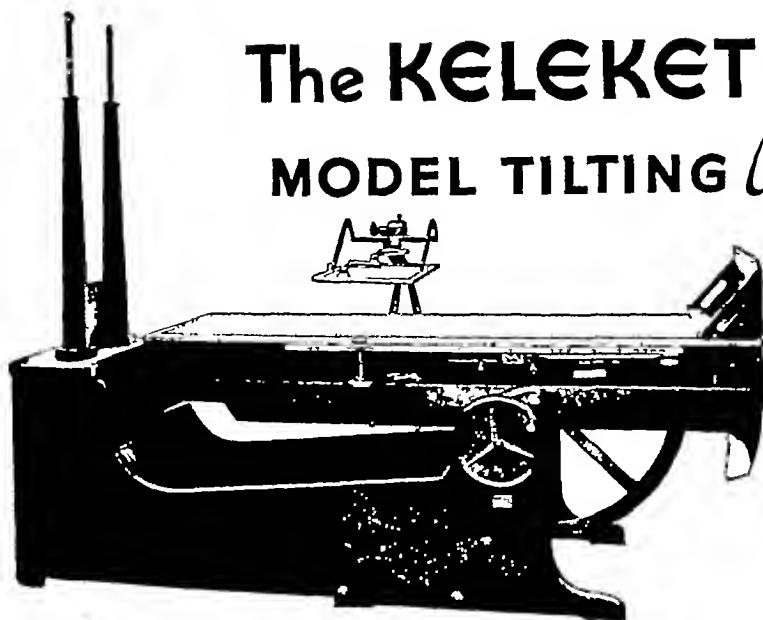


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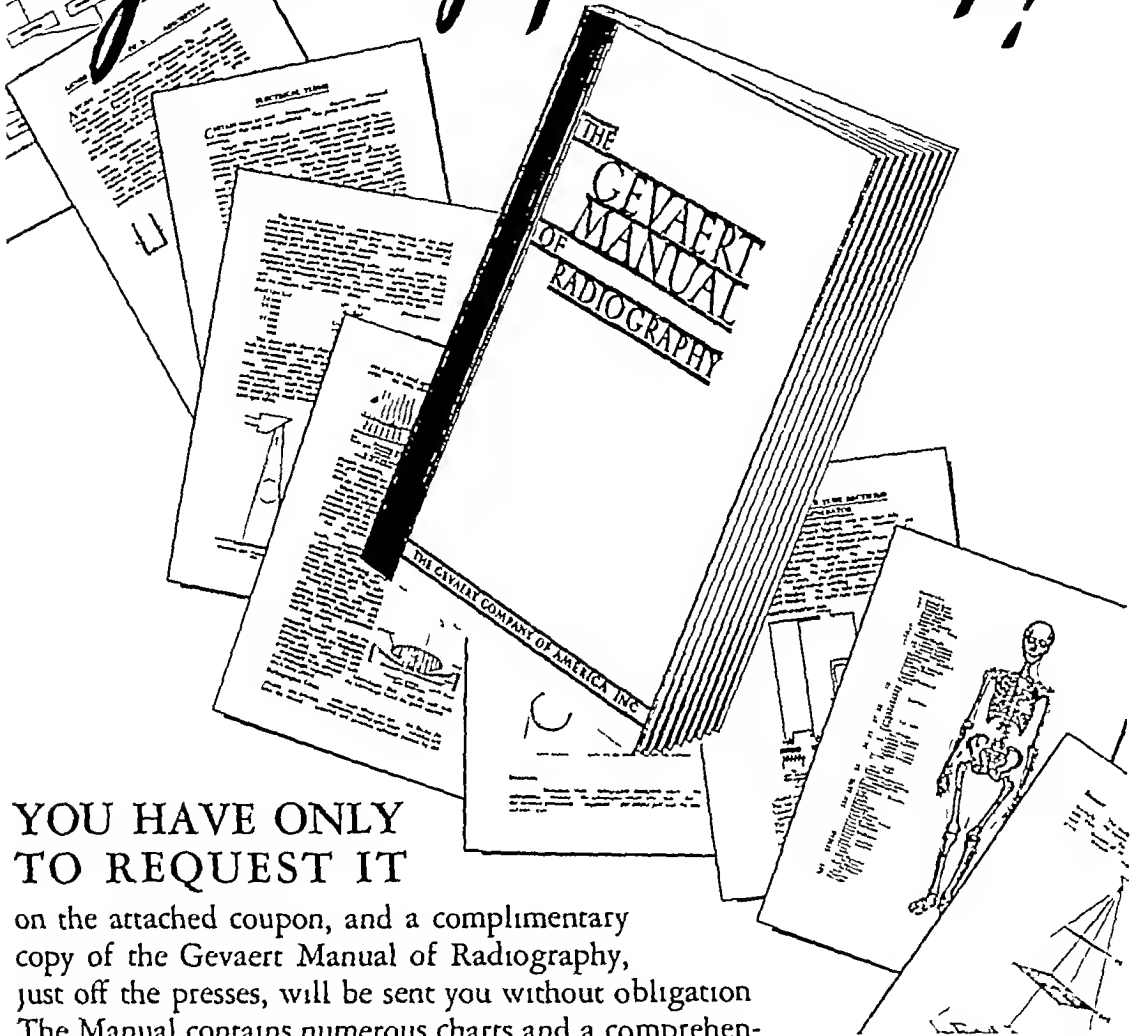


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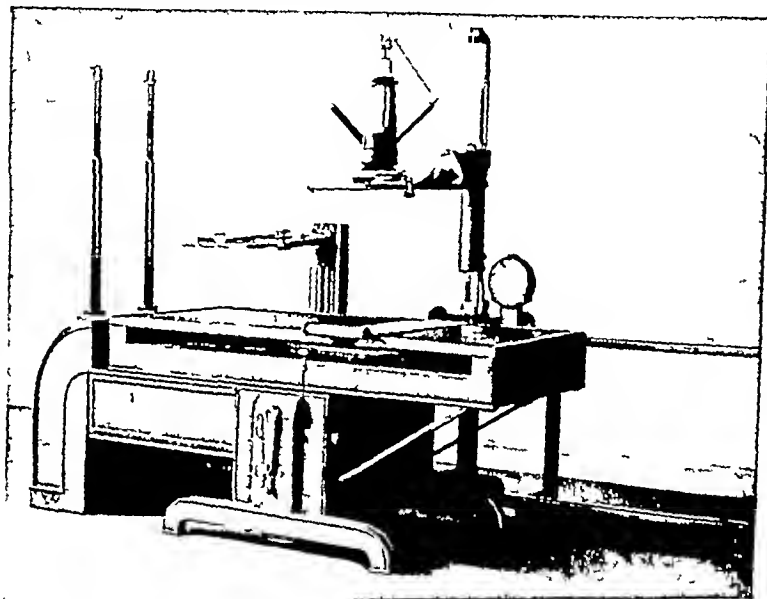
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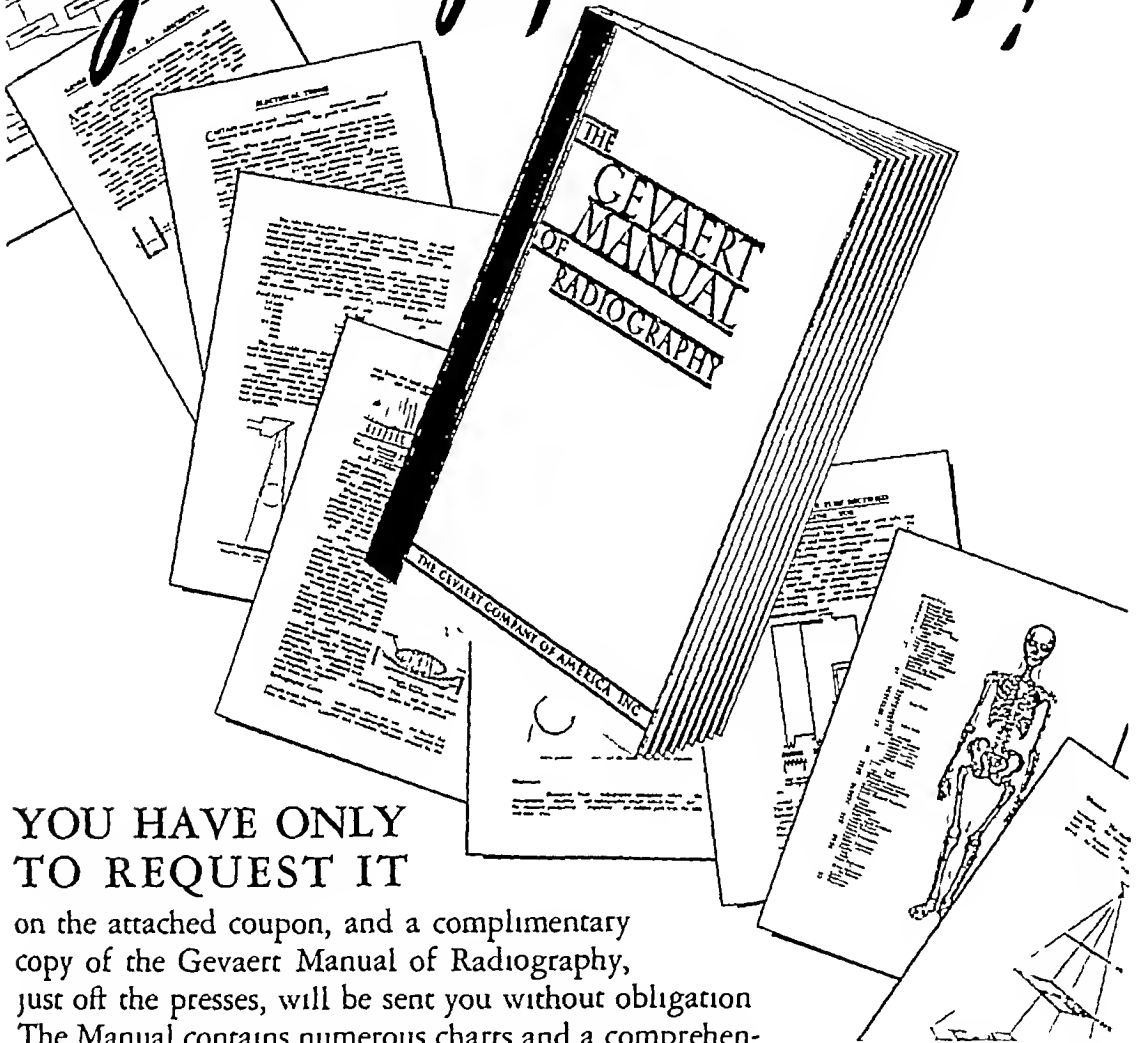
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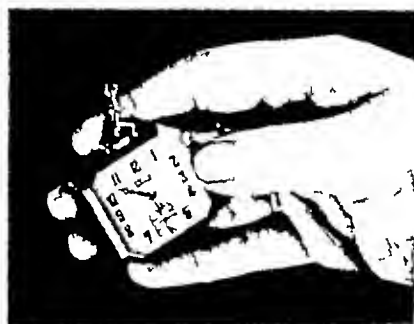
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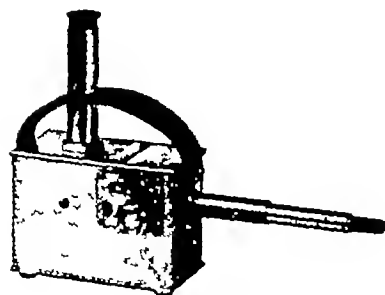
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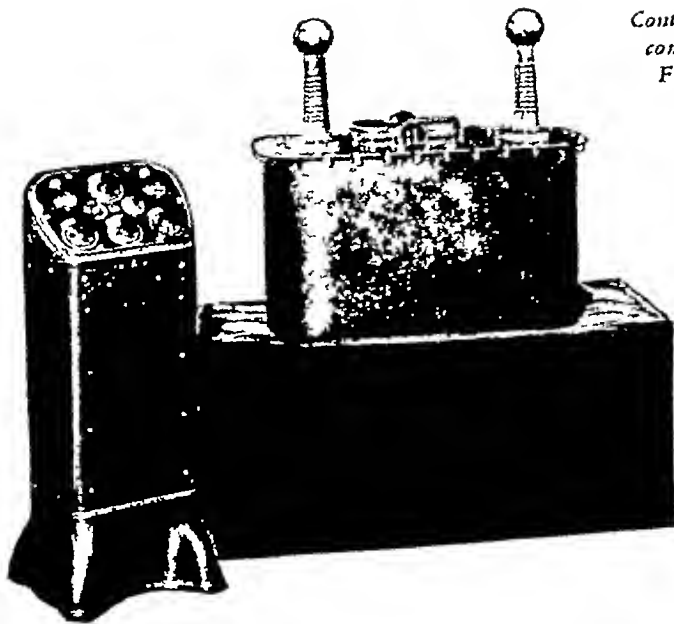
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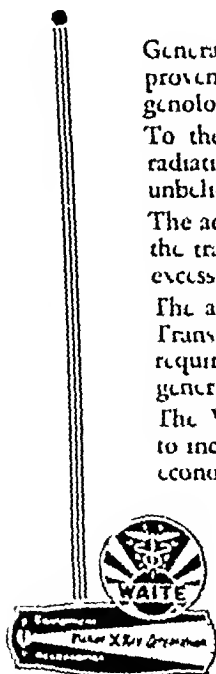
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